VR2250 INSTALLATION ANALYSER

MULTIFUNCTION TEST INSTRUMENT

USER INSTRUCTION MANUAL

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1. SAFETY PRECAUTIONS AND PROCEDURES

1.1. FORWARDS

This apparatus conforms with safety standards EN61557 and EN 61010-1 relating to electronic measuring instruments.

CAUTION

For your own safety as well as that of the apparatus you are recommended to follow the procedures described in this instruction manual and carefully read all the notes preceded by the symbol⚠.

Strictly keep to the following instructions before and during measurements:

- ☞ Do not take measurements in wet environments or dusty places.
- ☞ Do not take measurements in environments with explosive gas or fuels.
- ☞ Keep yourself insulated from the object under test waiting for measuring.
- ☞ Avoid any contact with exposed metal parts, ends of test leads not in use, circuits, etc.
- ☞ Do not take any measurement in case of unusual conditions of the instrument such as deformation, breakage, leakage of substances, absence of display reading etc.
- ☞ Do not use the External power supply adapter (optional code MAR####) if you notice deformation, or breakage in the case, in the wire or in the plugs.
- ☞ Pay careful attention when measuring voltages exceeding 25V in particular places (building yards, swimming pools, etc.) and 50V in ordinary places because of the risk of electric shock.
- ☞ Use only cables and accessories approved by Martindale Electric.

The following symbols are used in this manual:

⚠ Caution: refer to the instructions reported in this manual; improper use may damage the apparatus or its components.

O AC Voltage or Current.

Unidirectional pulsating Voltage or Current.

Rotary switch of the instrument.

1.2. PRELIMINARY INSTRUCTION

- ☞ This instrument has been designed for use in environments with a pollution level 2 and up to (and no more than) 2000 meters altitude.
- ☞ It can be used for Safety Test on Installation with Over voltage Category III 300V~ (phase to earth) and for **voltage and current** measurements on installations with over voltage category III 600 V~ phase to phase / 300 V~ phase to earth or CATII 350 V phase to earth.

- ☞ Please keep to the usual safety standards aimed at:
  - ♦ Protecting against dangerous currents;
  - ♦ Protecting the instrument against incorrect operations.
- ☞ Only the accessories supplied with the instrument guarantee compliance with the safety standards. Accordingly, they must be in good condition and, if necessary, they must be replaced with identical models.
- ☞ Do not take measurements on circuits exceeding the specified current and voltage limits.
- ☞ Before connecting cables, crocodiles and clamps to the circuit under test, make sure that the right function has been selected.
- ☞ Do not take any measurements under environmental conditions beyond the limits specified in paragraph 14.4.
- ☞ Check that batteries are not weak and inserted correctly.
- ☞ Before connecting test leads to the circuit under test, check that rotary switch position is correct.

1.3. DURING USE

Please read carefully the following recommendations and instructions:

CAUTION

No compliance with the Warnings and/or Instructions may damage the apparatus and/or its components or injure the operator.

- ☞ Before selecting any function disconnect the test leads from the circuit under test.
- ☞ When the instrument is connected to the circuit under test do not touch any unused terminals.
- ☞ Avoid taking resistance measurements in the presence of external voltages; even though the instrument is protected, a too high voltage may cause malfunctions.
- ☞ When measuring current, other currents located near the leads may affect the measuring accuracy.
- ☞ When measuring current, always position the wire in the very middle of the jaws in order to obtain the highest accuracy.
- ☞ A measured value remains constant if the "HOLD" function is active. Should you notice that the measured value remains unchanged, disable the “HOLD” function.

CAUTION

The symbol "▮" shows the battery status: When it is completely black the batteries are fully charged, while the "▯" symbol indicates weak batteries. When the batteries are too low to execute the test the instrument will show a warning message. In this case interrupt testing and replace batteries following the procedure described under paragraph 13.2. **The instrument is capable of keeping the data stored even though batteries are not installed. The Instrument Date and Time settings aren't lost if you change the batteries within 24hours.**

1.4. AFTER USE

- After use, turn off the instrument by pressing ON/OFF for a few seconds.
- Remove batteries when the apparatus remains unused for long periods. Please follow the storage instructions described at paragraph 14.4.

2. GENERAL DESCRIPTION

2.1. INTRODUCTION

Dear Customer, we thank you for your patronage. The instrument you have just purchased will grant you accurate and reliable measurements provided that it is used according to the present manual's instructions.
The instrument was designed to grant the user the utmost safety conditions thanks to a new concept assuring double insulation and over voltage category III.

2.2. FUNCTIONS

The instrument is able to perform the following tests:

- **LOWΩ**: Continuity Test of Protection and Equalising conductors with test current higher than 200mA and open circuit voltage ranging from 4V to 24V.
- **MΩ**: Measurement of insulation resistance with DC test voltage 50V, 100V, 250V, 500V or 1000V.
- **RCD**: Measurement on common and/or selective RCDs AC type (∿) and A type (⎍) of the following parameters:
  - ✓ Tripping time.
  - ✓ Tripping current.
  - ✓ Contact voltage (U_t).
  - ✓ Global earth resistance (R_a).

  Under this mode the instrument can measure the overall earth resistance without causing RCD tripping.
- **LOOP**: Measurement of line and fault loop impedance with calculation of prospective short circuit current, Measurement of fault loop impedance between phase and earth and Global Earth resistance measurement without RCD tripping and calculation of prospective short circuit current, Indication of phase rotation sequence
- **EARTH** Measurement of Earth Resistance and Resistivity using Earth rods.
- **AUX**: Measurement and Recording of leakage current using flexible clamp.
- **ANALYSER**: The Instrument allows the following operations:
  - ✓ **Display in real time** the electrical parameters of a single phase systems and the harmonic analysis of voltage and current.
  - ✓ **Conduct a direct Energy measurement** (without memorizing).
  - ✓ **Memorize** (pressing SAVE key) the sampled values of the Parameters present at instrument input generating a "Smp" record inside instrument memory. **It will be possible to analyse the memorized data ONLY by transferring the data to a PC.**
  - ✓ **Record simultaneously** (pressing the START key after a proper setting): RMS values of voltage, current, corresponding harmonics, active, reactive and apparent powers, power factors and cosφ, active, reactive and apparent energies, voltage anomalies (voltage sag and surge) with 10ms resolution. **It will be possible to analyse the recorded data ONLY by transferring the data to a PC.**

CAUTION

Please note the difference between **memorize** and **record**. These terms will be used repeatedly in this manual. Please focus on their definitions and distinctions.

3. PREPARATION FOR USE

3.1. INITIAL CONTROL

This instrument has been checked mechanically and electrically prior to shipment.
All care has been taken to ensure that the instrument reaches you under safe conditions.

You are recommended, however, to carry out a rapid check to detect any possible damage which might have been caused during transport. Should this be the case, immediately contact the distributor.

Check also that the packaging contains all the parts listed under paragraph 14.5. In case of discrepancies contact the distributor.

In case you have to send the instrument back please follow the instructions reported in paragraph 15.

3.2. POWER SUPPLY

The instrument can be powered by:

- ✓ 6 batteries 1.5V AA - LR6 series located in the compartment on the back of the instrument (not included in the package). For battery life see paragraph 14.3.1.
- ✓ An external power supply adapter (optional code MAR####) **to be used only for ANALYSIS and AUX function**. It is recommended that the MAR#### Power Supply adapter is used for long-term measuring.

CAUTION

For your own safety it's not permitted to use the external power supply adapter during Safety Test (LOWΩ, MΩ, RCD, LOOP, EARTH rotary Switch positions). If you press the START button the Instrument will show the message "⚠ REMOVE POWER".

The symbol shows the battery status: If it is completely "black" the batteries are fully charged, while the symbol indicates weak batteries. When the batteries are too low to execute the test the instrument will show a warning message.
In this case interrupt testing and replace batteries following the procedure described under paragraph 13.2. **The instrument is capable of keeping the data stored even though batteries are not installed. The Instrument Date and Time settings aren't lost if you change the batteries within 24hours.**

CAUTION

For recordings (ANALYSIS and AUX function) it is recommended to ALWAYS use the external power supply adapter (optional code MAR####), although the instrument does allow the operator to perform a recording using internal batteries. If during a recording the external power supply adapter is de-energised, the instrument will continue the recording using the internal battery power until the batteries are exhausted (the data stored up to the point the instrument shuts down won't get lost). It is recommended to **ALWAYS insert a new set of batteries before a long recording.**

The instrument uses sophisticated algorithms to prolong the battery life. Particularly:

- ✓ The instrument switches OFF the backlight automatically after 5 seconds.
- ✓ If the instrument is displaying in real time (and the external power supply adapter is not connected), after about 5 minutes from the last key press or switch rotation the instrument turns off automatically ("AUTOPOWER OFF" procedure).
- ✓ If the instrument is recording or is measuring energy (and the external power supply is not connected), after about 5 minutes from the last key pressure or switch rotation the instrument starts a special procedure to save the batteries ("ECONOMY MODE"): the instrument keeps recording but the display is turned off.

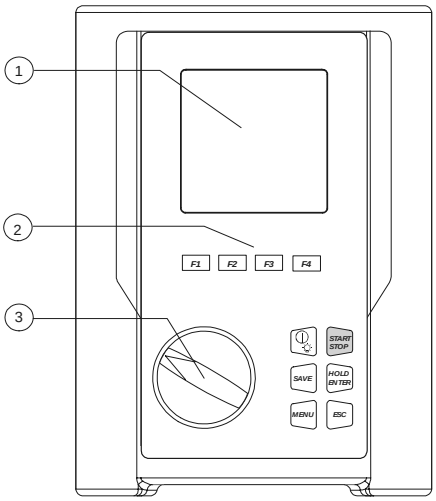
3.3. CALIBRATION

The instrument fulfils the technical specifications listed in this manual. The performance of the specifications is guaranteed for one year.

3.4. STORAGE

In order to grant the accuracy of the measurements, after a period of storage in extreme environmental conditions, wait for the time necessary so that the apparatus is back to normal measuring conditions (see environmental specifications listed in paragraph 14.4).

4. INSTRUMENT DESCRIPTION



LEGEND:

1. **Display**
2. **Function Keys**
3. **Rotary switch**

F1 **F2** **F3** **F4** ☞ Multifunction Keys.

ON/OFF ☞ **ON/OFF** and backlight key. Press it for a few seconds to switch OFF the instrument, press it briefly to activate the backlight function.

START STOP ☞ This key is used to start and stop the measurement.

SAVE ☞ This key allows you to save the result displayed.

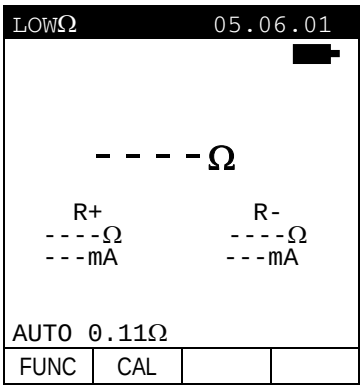
HOLD ENTER ☞ This key has a double function. It is the confirmation key inside the configuration menu and it allows you to freeze the displayed results using the ANALYSER function.

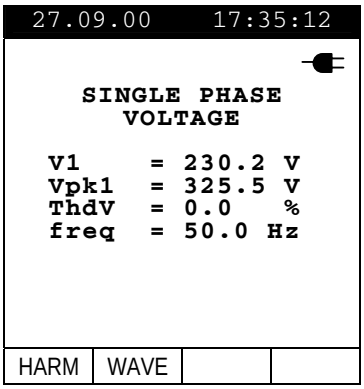
MENU ☞ This key opens the General Configuration Menu.

ESC ☞ This key allows you to quit the modification in the configuration menu or the selected working mode.

4.1. DISPLAY DESCRIPTION

The display is a graphic module with a resolution of 128 x 128 pixels
The first line of the display shows the date and time. If not correct, you can set these according to the procedure described at paragraph 5.2.
On the top right corner of the display you can always see the battery indicator and, if the external power supply adapter (optional code MAR####) is connected, the corresponding symbol.

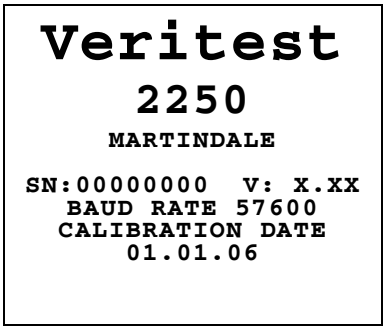




These symbols will be omitted in the following illustrations.

4.2. INITIAL SCREEN

When turning on the instrument by pressing ON/OFF, this screen will appear for a few seconds:



Here you can see:

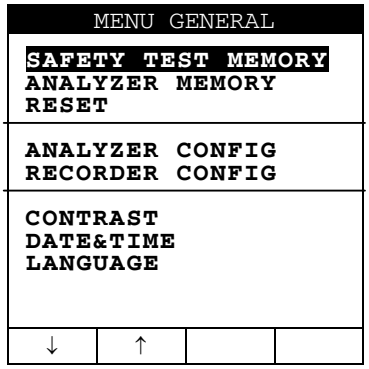
- Serial number of the instrument (SN :)
- Firmware software release (V.X.XX :)
- transmission speed through serial RS232 (Baud Rate)
- Calibration date (CALIBRATION :)

4.3. BACKLIGHT FUNCTION

When instrument is turned on, pressing briefly the **ON** button, the backlight will be enabled. The light will be automatically turned off after 5 seconds.
If the batteries are too low the instrument will disable automatically the backlight function.

5. INITIAL SETTINGS

By pressing the **MENU** key the following screen will be displayed:



It's not possible to enter the **MENU** during a recording or a Real Time Energy measurement. Pressing this button during a recording the display will show main recording parameter (see paragraph 10.3)

5.1. HOW TO ADJUST THE CONTRAST

By pressing the multifunction keys **F1** and **F2**, position the cursor on the **CONTRAST** item and confirm it by pressing the **ENTER** key.
By pressing the multifunction keys **F3** and **F4**, adjust the contrast (higher values correspond to a higher contrast while lower values correspond to a lower contrast) and press the **ENTER** key to **SAVE** the change or press **ESC** to quit without saving.
This setting will remain unchanged after turning off the instrument.

5.2. HOW TO SET DATE AND TIME

By pressing the multifunction keys **F1** and **F2**, position the cursor on the **DATE&TIME** item and confirm it by pressing the **ENTER** key.

The time is expressed as **hh:mm** (2 digits for hours, 2 digits for minutes) 24 hour clock.
Press the **ENTER** key to **SAVE** the change or press **ESC** to quit without saving.
This setting will remain unchanged also after turning off the instrument.

5.3. HOW TO SET THE LANGUAGE

By pressing the multifunction keys **F1** and **F2**, position the cursor on the **LANGUAGE** (EN) item and confirm it by pressing the **ENTER** key.
By pressing the multifunction keys **F1** and **F2**, position the cursor on the desired language and press the **ENTER** key to SAVE the change or press **ESC** to quit without saving.
This setting will remain unchanged after turning off the instrument.

5.4. RESET

This option re-establishes the initial settings of the instrument in **ANALYSER** function.

The “Current Range” parameter it is not modified by the reset command.

The initial settings of the instrument consist of:

- ✓ ANALYZER CONFIG:

System:	SINGLE
Frequency:	60Hz
Current range:	not modified
Clam type:	STD
Transforming ratio of voltmet transformers:	1
Password:	OFF

- ✓ RECORDER CONFIG:

Start:	MANU (the recording is started at 00 sec mark on clock after pressing the START/STOP key)
Stop:	MAN
Integration period:	15min
Recording of harmonics:	ON
Recording of Voltage anomalies (Sag and Surge):	ON
Voltage Reference for Sag and Surge detection:	230V
Upper Limit for Sag and Surge detection:	6%
Lower Limit for Sag and Surge detection:	10%
Selected voltages:	V1
Selected voltage harmonics:	THD, 01, 03, 05, 07
Selected currents:	I1
Selected current harmonics:	THD, 01, 03, 05, 07
CO-GENERATION:	OFF
Powers, Pf and cosφ selected:	P1
	Q1i
	Q1c
	S1
	Pf1
	DPf1
Energies:	Ea1
	Eri1
	Erc1

The RESET command <u>will not</u> erase the instrument’s memory.

6. SAFETY TEST FUNCTIONS

6.1. LOWΩ: CONTINUITY TEST WITH 200mA TEST CURRENT

The measurement is performed according to EN 61557-2 and VDE 0413 part 4.

CAUTION

Before carrying out the continuity test make sure that there is no voltage at the ends of the conductor under test.

Turn the **switch** to the **LOW Ω** position.

F1 This key permits you to select one of the following measuring modes:

- ☞ Mode "**AUTO**" (the instrument carries out two measurements with reversed polarity and displays their average value). This mode is recommended for the continuity test.
- ☞ Mode "**RT+**" (measurement with positive polarity and possibility of setting the duration time of the test). In this case the operator can set a measuring time long enough to permit him to move the protective conductors while the instrument is carrying out the test so detecting any bad connection.
- ☞ Mode "**RT-**" (measurement with negative polarity and possibility of setting the duration time of the test). In this case the operator can set a measuring time long enough to permit him to move the protective conductors while the instrument is carrying out the test so detecting any bad connection.

F2 This key permits to execute the "**CAL**" mode (compensation of the resistance of the cables used for the measurement).

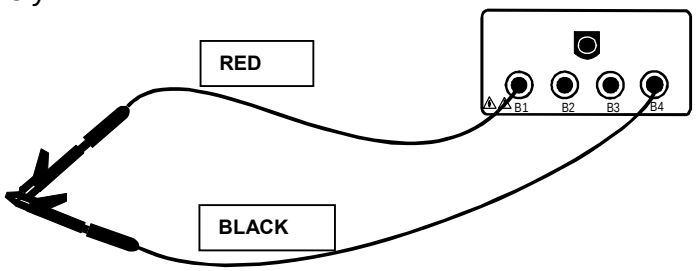
CAUTION

If the resistance is lower than 5Ω (including the resistance of the calibration) the continuity test is executed by the instrument with a test current higher than 200mA. If the resistance is higher than 5Ω the continuity test is executed by the instrument with a current lower than 200mA.

We recommend that you check the Calibration of the test leads before executing a measurement according to the next paragraph (6.1.1).

6.1.1. Calibrating the test leads ("CAL" Mode)

1. Connect the Red and Black test leads to **B1** and **B4** input terminals respectively.



Connection of the test leads during calibration procedure.

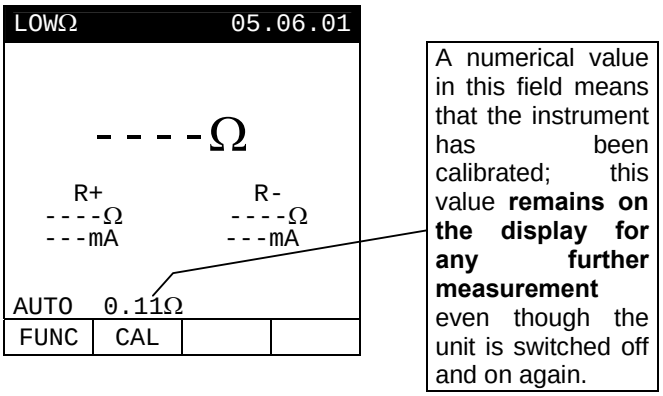
2. If the test leads supplied with the instrument are not long enough for the measurement you can extend the black cable.
3. Short-circuit the measuring cable ends making sure that the conductive parts of the crocodiles make a good contact to each other (see previous picture).

F2

4. Press the **F2** key. The instrument carries out the calibration.

CAUTION

Never disconnect the test leads when the message **"MEASURING"** is displayed.



5. At the end of the test the result is stored and used as **OFFSET (that is to say that it is subtracted from any continuity test carried out)** for all the subsequent measurements.

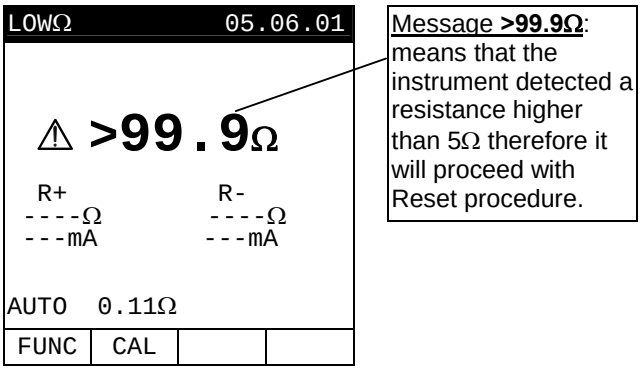
Note: The instrument performs the calibration only if the resistance of the test leads is lower than **5Ω**.

TEST LEADS

Before each measurement always make sure that the calibration is applicable to the test leads in use. During a continuity test, if the resistance value free of calibration (that is the resistance value is less than the calibration offset value) is **negative**, the symbol ⚠ is displayed. Probably the calibration resistance value stored in the instrument memory is not applicable to the test leads in use; therefore a new calibration must be performed.

6.1.1.1. Procedure to reset test leads calibration parameters

☞ To cancel calibration parameters it is necessary to perform a **calibration procedure with a <u>resistance of test leads higher than 5Ω</u>** (for example with open test leads). When a cancellation is performed **the screen nearby** is displayed along side:

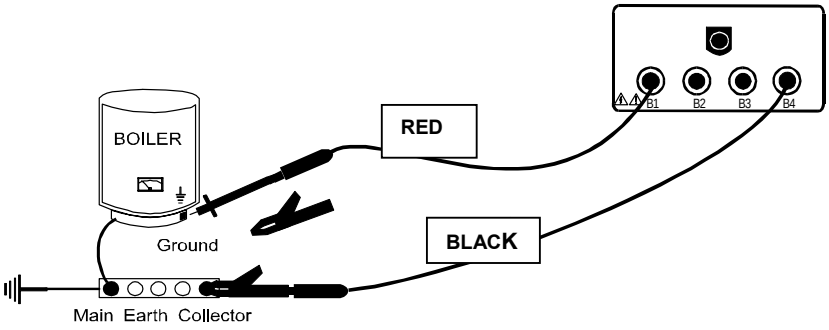


Message **>99.9Ω**: means that the instrument detected a resistance higher than 5Ω therefore it will proceed with Reset procedure.

6.1.2. Measurement Procedure

F1

1. Select the desired mode by means of the **F1** key.
2. Connect the red and black test leads to **B1** and **B4** input terminals respectively



Connection of the test leads during LOWΩ test.

3. If the cables supplied with the instrument are not long enough for the measurement you can extend the black cable.
4. Short-circuit the test leads making sure that the conductive parts of the crocodiles make a good contact to each other. Press the START key. **If the display doesn't show 0.00Ω repeat the test leads calibration** (see paragraph 6.1.1).
5. Connect the instrument terminals to the ends of the conductor under test (see previous picture).

F3
F4

6. **If the mode "RT+" or "RT-"** was selected use the **F3**, **F4** keys to set the duration of the test.

START STOP

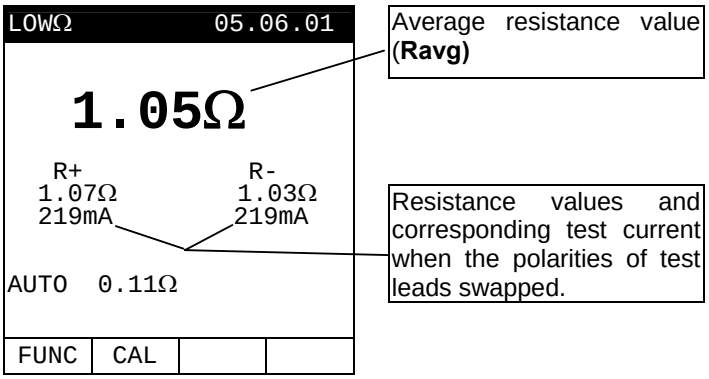
7. Press the **START** key. The instrument will execute the measurement. In RT+/RT- (Timer mode) you can press START key again if you want to stop the test before the duration set is expired.

CAUTION

Never disconnect the test leads when the message **"MEASURING"** is displayed.

6.1.3. Results of "AUTO" mode

☞ At the end of the test, if the **average resistance value <u>Ravg</u> is <u>lower than 5Ω</u>** the instrument emits a **double sound signal** indicating the **positive outcome of the test** and displays one screen similar to the screen alongside.

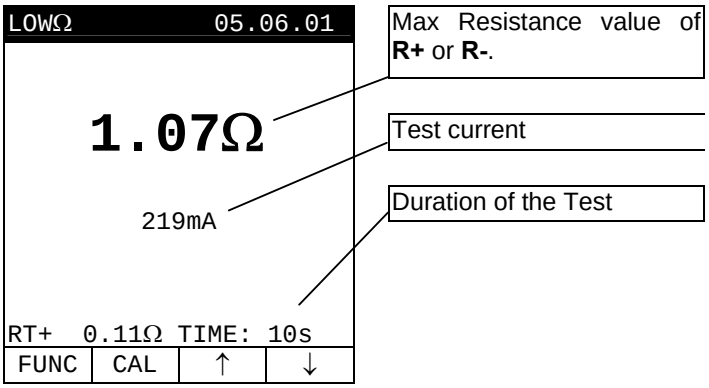


SAVE

The displayed result can be stored pressing the **SAVE** key **twice** (according to paragraph 9.1).

6.1.4. Results of "RT+" and "RT-" modes

☞ if a **resistance value RT+** or **RT+ lower than 5Ω** is detected, the instrument emits a **double sound signal indicating the positive outcome** of the test and displays one screen similar to the screen alongside.

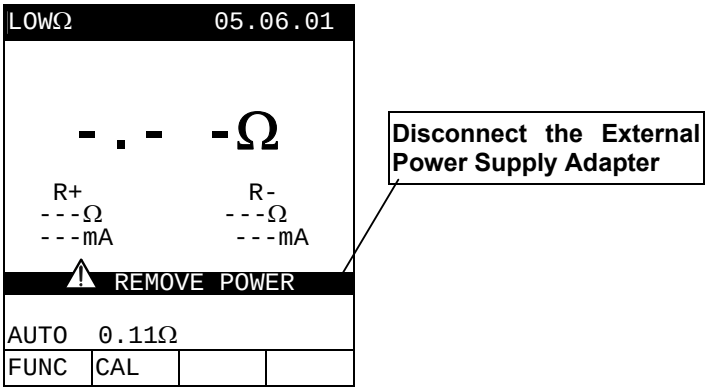


Note: We recommend that crocodile clips are used to attain a good contact with the conductor under test. Indeed in this test the instrument gives as final result the maximum measured value of R+ or R- and using test leads instead of crocodile clips could give you a faulty result due to a faulty contact between the test leads and conductor under test.

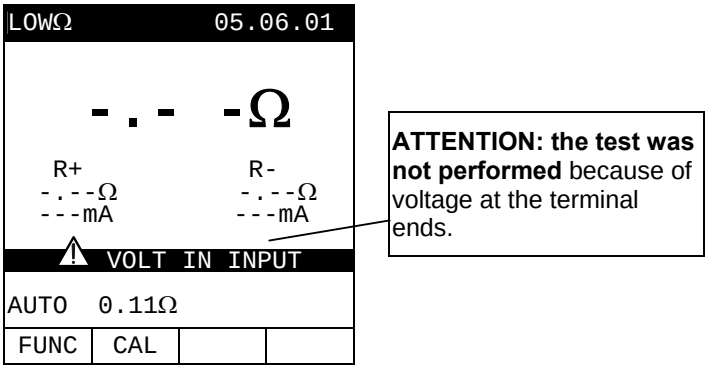
SAVE The displayed result can be stored pressing the **SAVE** key **twice** (according to paragraph 9.1).

6.1.5. "AUTO", RT+", "RT-" faulty cases

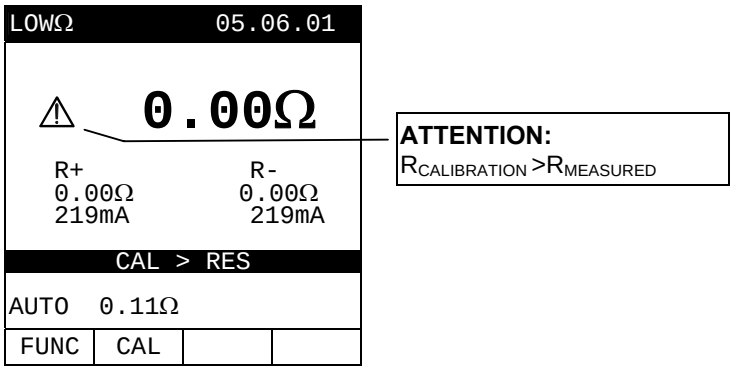
☞ If the instrument detects the External Power supply adapter connected to the instrument will display the screen along side.



☞ If the terminal voltage is higher than 15V, the instrument does not carry out the test and displays the screen alongside for 5 seconds.

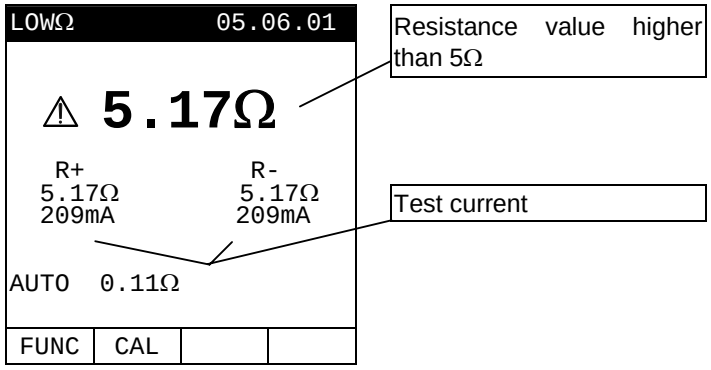


☞ In case that: **$R_{CALIBRATION} > R_{MEASURED}$** the instrument displays the screen alongside.



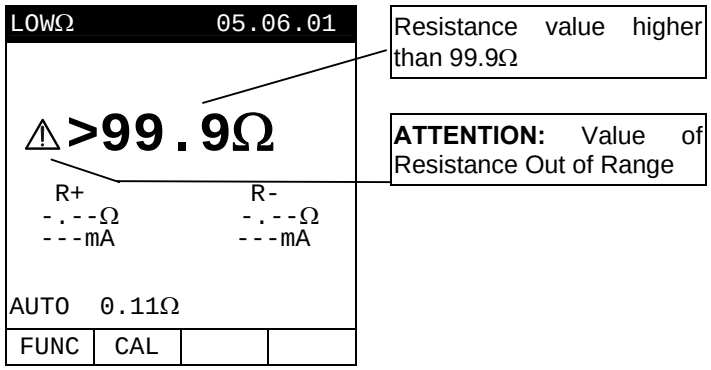
<u>THE PREVIOUS RESULTS CANNOT BE SAVED</u>.

☞ If the value of **<u>Resistance is higher than 5Ω</u>** (but lower than 99.9Ω) the instrument **emits a long sound signal** and displays one screen similar to the screen alongside



SAVE The displayed result can be stored pressing the **SAVE** key **twice** (according to paragraph 9.1).

☞ If the value of **<u>Resistance is higher than 99.9Ω</u>** the instrument emits **a long sound signal** and displays the screen alongside.



SAVE The displayed result can be stored pressing the **SAVE** key **twice** (according to paragraph 9.1).

6.2. MΩ: INSULATION RESISTANCE MEASUREMENT WITH 50V, 100V, 250V, 500V, 1000V TEST VOLTAGE

These measurement comply with IEC 61557-2 and VDE 0413 part 1.

CAUTION

Before affecting the insulation test make sure that the circuit under test is not energised and all the loads are disconnected.

Turn the **switch** to the **MΩ** position.

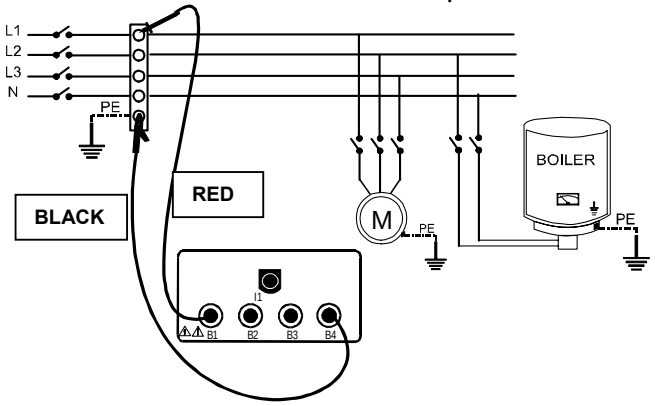
F1 The key **F1** permits to select one of the following measuring modes:

- ☞ Mode "**MAN"** (Manual mode). Recommended test.
- ☞ Mode "**TMR**" (Timer mode: test duration depends on the selected interval from 10 to 999 seconds). This test can be performed when the test requires a defined duration.

6.2.1. Measurement Procedure

F1 1. Select the desired mode by means of the **F1** key.

2. Connect the test leads to the instrument input terminals **B1** and **B4** respectively,



Example: insulation measurement between phase L1 and earth in a 3 PHASE electrical installation using test leads.

3. If the cables supplied with the instrument are not long enough for the measurement you can extend the black cable.
4. Connect the instrument terminals to the object which is to be submitted to the insulation test **after de-energizing the circuit under test and all the relative loads** (see previous picture).

F2 5. By means of **F2** select the test voltage suitable for the type of test to be carried out (see Table1). The values to be selected are:

- 50V (test on telecommunication system)
- 100V
- 250V
- 500V
- 1000V

Standard	Brief description	Test voltage	Maximum limit value
CEI 64-8/6	Systems SELV or PELV Systems up to 500V (Civil installations) Systems over 500V	250VDC 500VDC 1000VDC	> 0.250MΩ > 0.500MΩ > 1.0MΩ
CEI 64-8/4	Floor and wall insulation in civil installations Floor and wall insulation in systems over 500V	500VDC 1000VDC	> 50kΩ (se V<500V) > 100kΩ (se V>500V)
EN60439	Electrical panel boards 230/400V	500VDC	> 230kΩ
EN60204	Electrical equipment of machines	500VDC	> 1MΩ

Table1: Table for test voltages and the corresponding limit values for reference.

Rated voltage selected for the test	R_{MAX} = Maximum resistance value
50VDC	99.9MΩ
100VDC	199.9MΩ
250VDC	499MΩ
500VDC	999MΩ
1000VDC	1999MΩ

Table2: Table of maximum resistance values which can be measured under MΩ mode depending on the rated voltage selected.

F3
F4

6. If the **"TMR"** mode was selected use the **F3**, **F4** keys to set the duration time of the test:

CAUTION

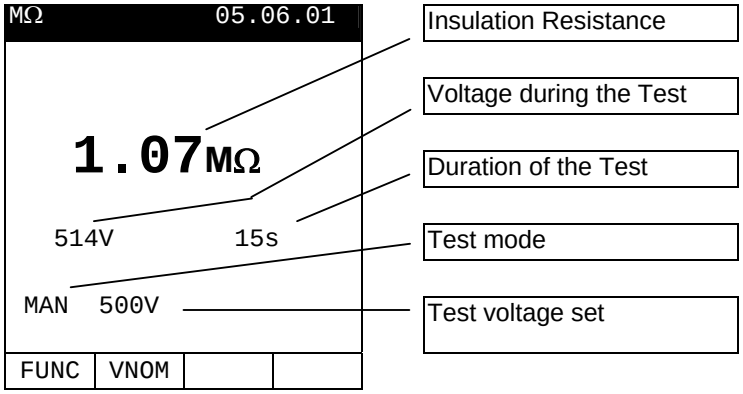
Never disconnect the test leads from the circuit under test when the message **"MEASURING"** is displayed as the circuit under test may remain charged at a dangerous voltage. The instrument has an internal "safety resistor" which is connected to output terminal before end of test in order to discharge the parasite capacities of the installation

START STOP

7. Press the **START** key.
   The instrument will start the test.
   - ✓ MAN Mode: The test will take 4 seconds (maximum). If you keep the START key pressed longer than 4 seconds the test continue until the key is released.
   - ✓ TMR mode: The test will take the time set. If you want to stop the test when it's running, press the START STOP key again.

6.2.2. Results of "MAN" mode

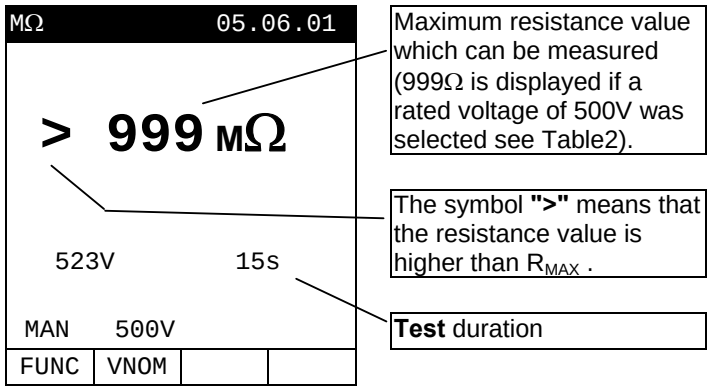
☞ At the end of the test if the Insulation resistance is **lower than R_{MAX}** (see **Table2**) **and the instrument generated the Nominal test Voltage**, the instrument emits a **double sound signal indicating the positive outcome of the test** and displays one screen similar to the screen alongside.



In order to evaluate the test you must compare the result with the limits indicated in the Guidelines (see Table1).

SAVE The displayed result can be stored pressing the **SAVE** key **twice** (according to paragraph 9.1).

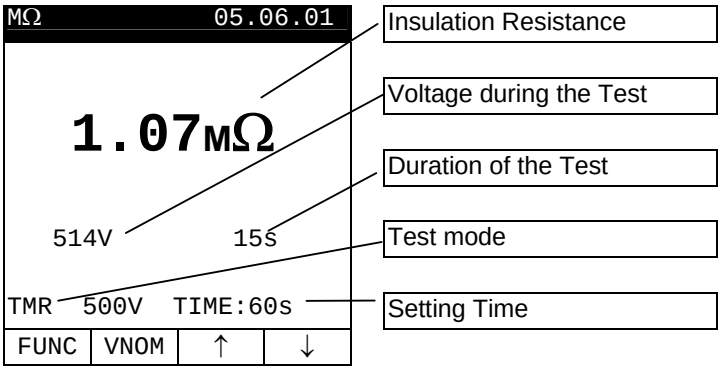
☞ If the Insulation resistance is **higher than R_{MAX}** (see **Table2**), the instrument emits a **double sound signal** at the end of the test **indicating the positive outcome of the test** and displays one screen similar to the screen alongside.



SAVE The displayed result can be stored pressing the **SAVE** key **twice** (according to paragraph 9.1).

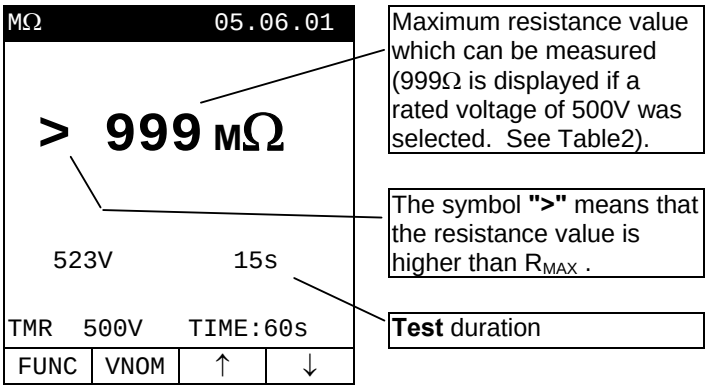
6.2.3. Results of "TMR" mode

☞ At the end of the test if the Insulation resistance is **lower than R_{MAX}** (see **Table2) and the instrument generated the Nominal test Voltage**, the instrument emits a **double sound signal indicating the positive outcome of the test** and displays one screen similar to the screen alongside.



SAVE The displayed result can be stored pressing the **SAVE** key **twice** (according to paragraph 9.1).

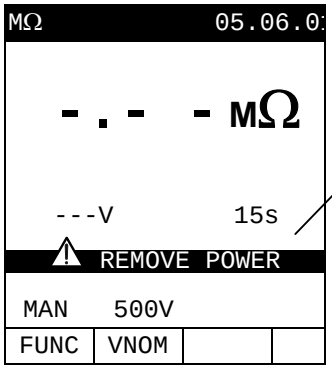
☞ If the Insulation resistance is **<u>higher than R_{MAX}</u>** (see **Table2**), the instrument emits a **double sound signal** at the end of the test **indicating the positive outcome of the test** and displays one screen similar to the screen alongside.



SAVE The displayed result can be stored pressing the **SAVE** key **twice** (according to paragraph 9.1).

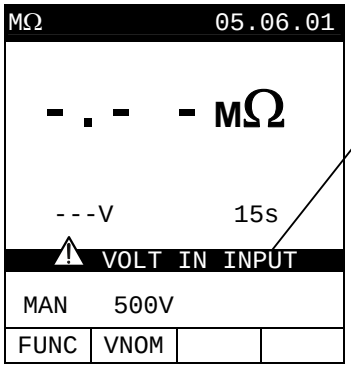
6.2.4. "MAN" and "TIMER" mode faulty cases

☞ If the instrument detects the External Power supply adapter connected to the instrument, the message along side will be displayed.



Disconnect the External Power Supply Adapter

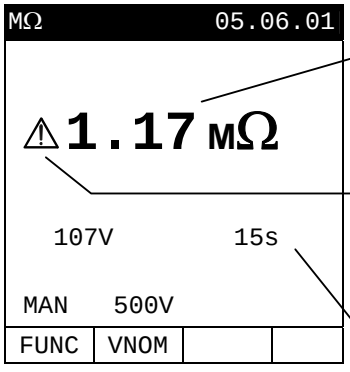
☞ If the instrument detects a Voltage between Input terminals higher than 15V, the instrument does not perform the test and displays the screen alongside for 5 seconds.



ATTENTION: the test cannot be executed. Check that the circuit is not energised.

These results cannot be saved

☞ If the instrument cannot generate the Nominal Test Voltage it will emit a **long acoustic signal** and displays a screen similar to the screen alongside.



Insulation Resistance

ATTENTION: the test of resistance **R_{ISO} was performed at a voltage value lower than the set rated voltage**. Low insulation case. This case occurs under low insulation conditions or in the presence of capacity on the installation.

Test Time

SAVE The displayed result can be stored pressing the **SAVE** key **twice** (according to paragraph 9.1).

6.3. RCD: TEST ON "A" AND "AC" RCDS TYPE

The test is executed according to IEC61557-6, EN61008, EN61009, EN60947-2 B 4.2.4 and VDE 0413 part 6.

CAUTION

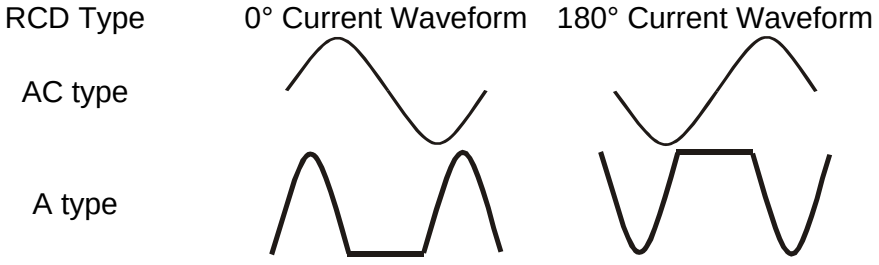
The automatic check of the RCD features causes the tripping of the RCD itself. Therefore **check that all devices connected downstream of the RCD under test are not damaged by power off.** Possibly disconnect all the loads connected downstream of the RCD as they could add additional leakage currents to the instrument ones and so making the test results void.

Turn the **switch** to the **RCD** position:

F1 The **F1** key permits to select one of the following measuring modes (which can be shown cyclically when pressing the key):

- Mode "**AUTO**" (the instrument performs the test automatically with a leakage current equal to half, once and five times the value of the rated current set). Recommended test.
- Mode "**x ½**" (the instrument performs the test with a leakage current equal to half the value of the rated current set).
- Mode "**x 1**" (the instrument performs the test with a leakage current equal to once the value of the rated current set).
- Mode "**x 2**" (the instrument performs the test with a leakage current equal to twice the value of the rated current set).
- Mode "**x 5**" (the instrument performs the test with a leakage current equal to five times the value of the rated current)
- Mode "▟" (the instrument performs the test with a ramp growing leakage current. Use this test to measure the tripping current).
- Mode **"R_A⏚"** (the instrument performs the test with a leakage current equal to half the value of the selected rated current and calculates the contact voltage as well as the R_a earth resistance).

N.B. The **AUTO** mode execute automatically test with phase 0° and 180°



According to standard practice it is recommended to perform the RCD test both with phase 0° and with phase 180° even with no AUTO modes. If the RCD under test is A type (which means sensitive to both AC and undirectional pulsing leakage currents) it is advisable to effect the test both with sine wave and undirectional pulse current with phase 0° and 180°.

F2 The **F2** key permits to select one of the following rated tripping currents of the RCD (which can be shown cyclically when pressing the key):

- ☞ 10mA.
- ☞ 30mA.
- ☞ 100mA.
- ☞ 300mA.
- ☞ 500mA.

F3 The **F3** key permits to select the RCD type (which can be shown cyclically when pressing the key):

- ☞ "α": general RCD AC type (sensitive to sine leakage current)
- ☞ "κ": general RCD A type (sensitive to pulsating leakage current)
- ☞ "$\alpha\mu$": selective RCD AC type (sensitive to sine leakage current)
- ☞ "$\kappa\mu$": selective RCD A type (sensitive to pulsating leakage current)

Note if the test is performed on **general RCDs** the symbol μ is NOT displayed

Note according to EN61008 the test on the selective RCDs requires an interval between the tests of 60 seconds (30 seconds in case of tests at ½ $I_{\Delta n}$). A timer is displayed indicating the waiting time for each step.

Example: Test with AUTO mode on a RCD with $I_{\Delta n}$=30mA.

a) The instrument performs the test at ½ $I_{\Delta n}$ 0°. The RCD must not trip.
b) The instrument performs the test at ½ $I_{\Delta n}$ 180°. The RCD must not trip. For a Selective RCD a 30 seconds timer starts before executing next test.
c) The instrument performs the test at $I_{\Delta n}$ 0°. If the RCD passed the test, it must trip and the instrument shows the message "RESUME RCD". The operator shall resume the RCD. For a Selective RCD a 60 seconds timer starts before executing the next test.
d) The instrument performs the test at $I_{\Delta n}$ 180°. Follow the same procedure as described under c).
e) The instrument performs the test at $5I_{\Delta n}$ 0°. Follow the same procedure as described under c).
f) The instrument performs the test at $5I_{\Delta n}$ 180°. Follow the same procedure as described under c). The test is completed.

F4 The F4 key permits to select one of the following **limit values for the contact voltage** (which can be shown cyclically when pressing the key):

- ☞ 50V (default)
- ☞ 25V.

CAUTION

Never disconnect the test leads when the message **"MEASURING"** is displayed.

6.3.1. Tripping times for the general and selective RCDs

☞ **Table of tripping times for $I_{\Delta N}$ x1, $I_{\Delta N}$ x2, $I_{\Delta N}$ x5 and AUTO tests.**
If the parameters set on the instrument comply with the type of RCD under test (and if the latter works properly) the test **x1**, **x2**, **and x5 SHALL** cause the RCD tripping within the times shown in the following table:

RCD type	$I_{\Delta N}$ x 1	$I_{\Delta N}$ x 2	$I_{\Delta N}$ x 5	Description
General	0.3s	0.15s	0.04s	**Max** tripping time in seconds
Selective **S**	0.5s	0.20s	0.15s	**Max** tripping time in seconds
	0.13s	0.05s	0.05s	**Minimum** tripping time in seconds

* For rated values I∆N ≤ 30mA the test current at five times is 0.25A.
For currents equal to ½ $I_{\Delta N}$ the RCD shall not trip in any case.

Table 3: Table of tripping times for tests with leakage currents $I_{\Delta N}$ x1, $I_{\Delta N}$ x2, $I_{\Delta N}$ x5 and AUTO.

☞ **Table of tripping times for ramp tests "⟋".**
This test should not be used to compare the RCD tripping time at the tripping current, while the standards refer to the maximum tripping times in case the RCD is checked with a leakage current equal to the rated current.
The limit values for the tripping current are indicated in the following Table:

RCD Type	$I_{\Delta N} \leq 10mA$	$I_{\Delta N} > 10mA$
A	**1,4 x $I_{\Delta N}$**	**1,4 x $I_{\Delta N}$**
AC	**$I_{\Delta N}$**	**$I_{\Delta N}$**

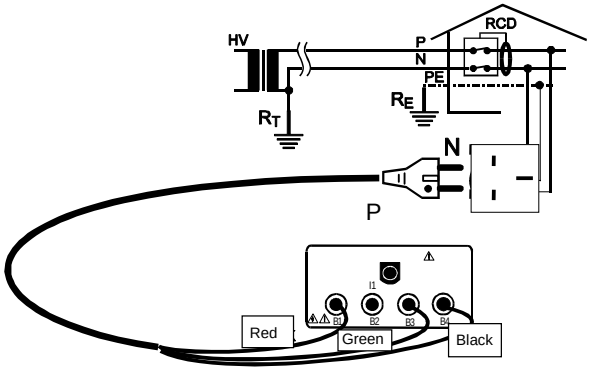
Table 4: Current limit value for "Ramp" Test

6.3.2. Measurement procedure

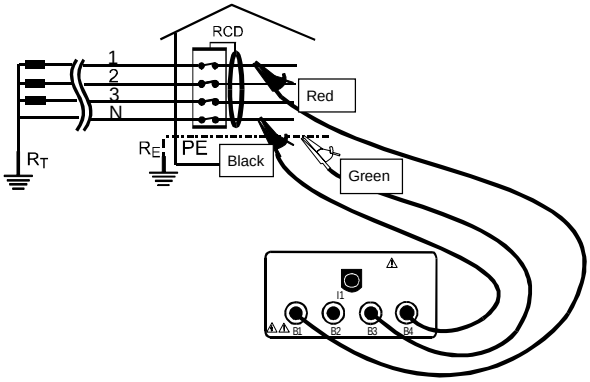
F1 F2
F3 F4

1. Select the desired test parameter by means of the **F1**, **F2**, **F3**, **F4** key.

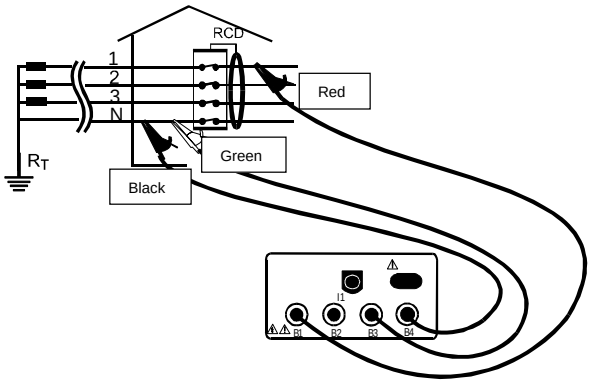
2. Connect the Red, Green and Black connectors of the three-terminal mains cable or of the split cables to the corresponding input terminals of the instrument **B1**, **B3**, **B4**



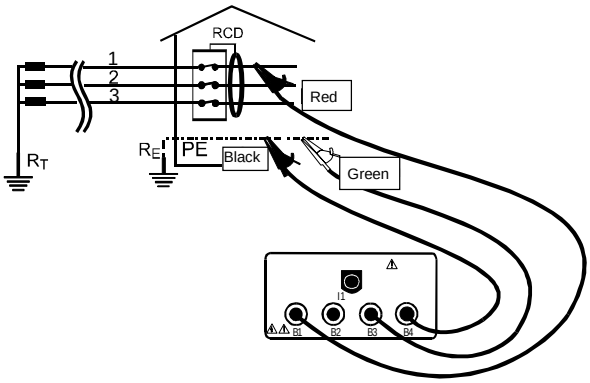
Instrument connection for 230V single-phase RCD check



Instrument connection for 400V + N + PE three-phase RCD check



Instrument connection for 400V + N (no PE) three-phase RCD check



Instrument connection for 400V + PE (no N) three-phase RCD check

3. Connect the mains plug or the Test leads to the System under test according to one of the diagrams above.

6.3.2.1. Results of "*x½*" mode

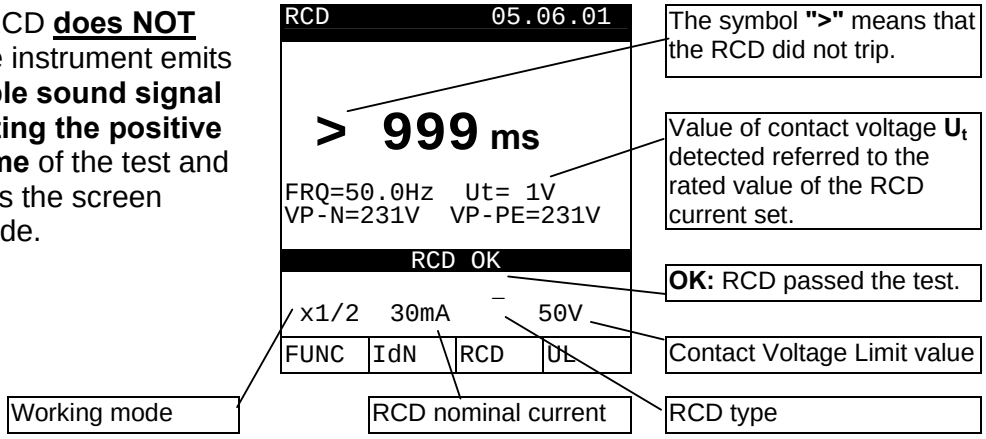
START STOP

4. Press the **START** key **once** to execute a test with **0°** Current waveform.
   or
   Press the **START** key **once** to execute a test with **180°** Current waveform.

CAUTION

Never disconnect the test leads when the message **"MEASURING"** is displayed.

☞ If the RCD **does NOT trip** the instrument emits a **double sound signal indicating the positive outcome** of the test and displays the screen alongside.



SAVE The test can be stored pressing the **SAVE** key **twice** (according to paragraph 9.1).

6.3.2.2. Results of "*x1*, *x2, x5*" mode

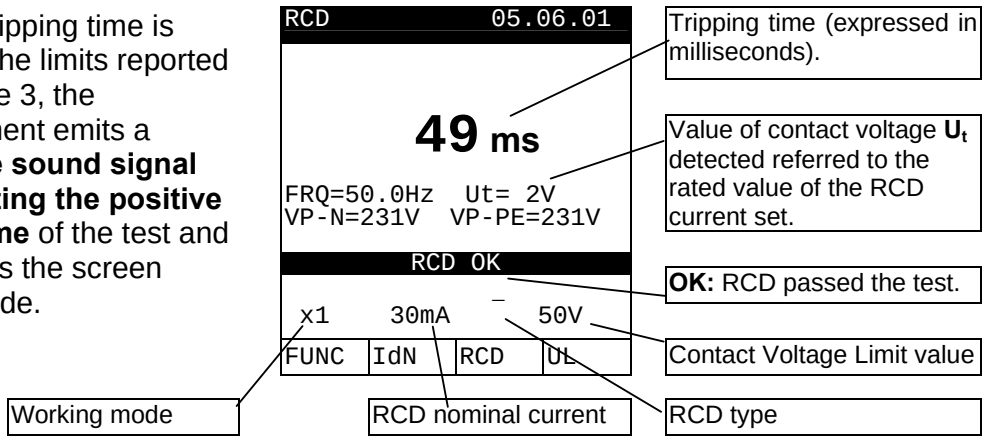
START STOP

4. Press the **START** key **once** to execute a test with **0°** Current waveform.
   Or
   Press the **START** key **once** to execute a test with **180°** Current waveform.

CAUTION

Never disconnect the test leads when the message **"MEASURING"** is displayed.

☞ If the tripping time is within the limits reported in Table 3, the instrument emits a **double sound signal indicating the positive outcome** of the test and displays the screen alongside.



SAVE The test can be stored pressing the **SAVE** key **twice** (according to paragraph 9.1).

6.3.2.3. Results of "*AUTO*" mode

START STOP

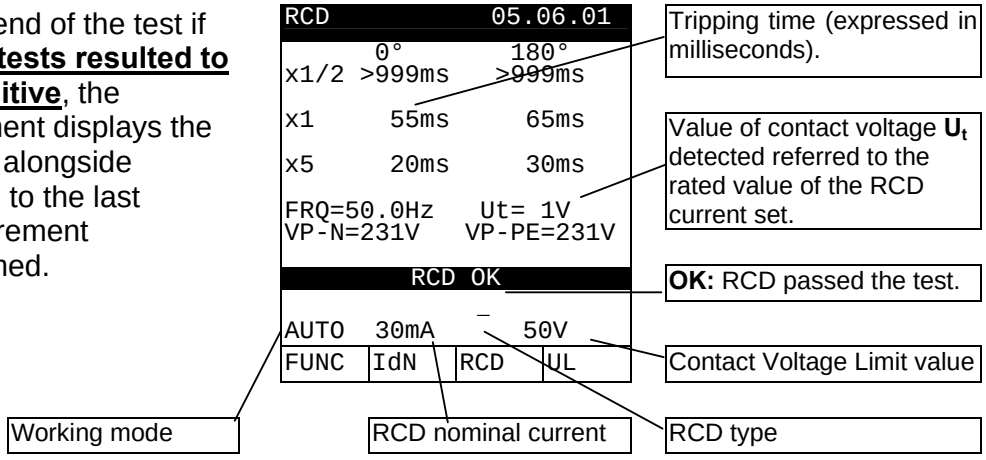
4. Press the **START** key **once** to execute the test. The instrument carries out the following six tests with different values of rated current:
   - ☞ $1/2I_{\Delta n}$ with 0° current waveform (the RCD shall not trip).
   - ☞ $1/2I_{\Delta n}$ with 180° current waveform (the RCD shall not trip).
   - ☞ $I_{\Delta n}$ with 0° current waveform (the RCD trips, message "**RESUME RCD**").
   - ☞ $I_{\Delta n}$ with 180° current waveform (the RCD trips, message "**RESUME RCD**").
   - ☞ $5I_{\Delta n}$ with 0° current waveform (the RCD trips, message "**RESUME RCD**").
   - ☞ $5I_{\Delta n}$ with 180° current waveform (the RCD trips, end of the test).

The test is good if all values of tripping times are within the limits reported in Table 3.

CAUTION

Never disconnect the test leads when the message **"MEASURING"** is displayed.

☞ At the end of the test if **all six tests resulted to be positive**, the instrument displays the screen alongside relative to the last measurement performed.



SAVE The test can be stored pressing the **SAVE** key **twice** (according to paragraph 9.1).

6.3.2.4. Results of "*RAMP* ▟" mode

START STOP 4. Press the **START** key **once** to execute a test with **0°** Current waveform.

Or

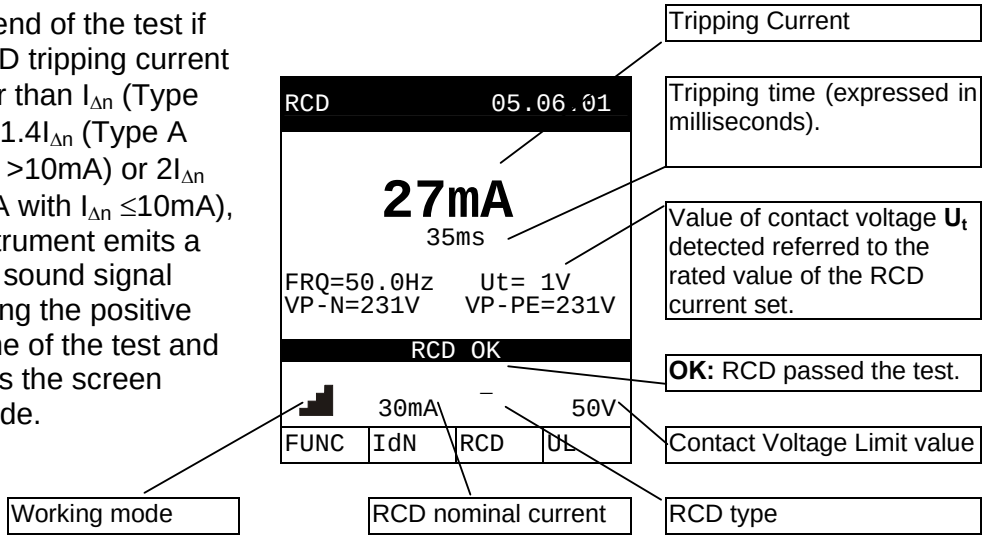
Press the **START** key **once** to execute a test with **180°** Current waveform.

The instrument generates a leakage current growing step by step for a given time interval.

CAUTION

⚠ Never disconnect the test leads when the message **"MEASURING"** is displayed.

☞ At the end of the test if the RCD tripping current is lower than $I_{\Delta n}$ (Type AC) or $1.4I_{\Delta n}$ (Type A with $I_{\Delta n}$ >10mA) or $2I_{\Delta n}$ (Type A with $I_{\Delta n}$ ≤10mA), the instrument emits a double sound signal indicating the positive outcome of the test and displays the screen alongside.



SAVE The test can be stored pressing the **SAVE** key **twice** (according to paragraph 9.1).

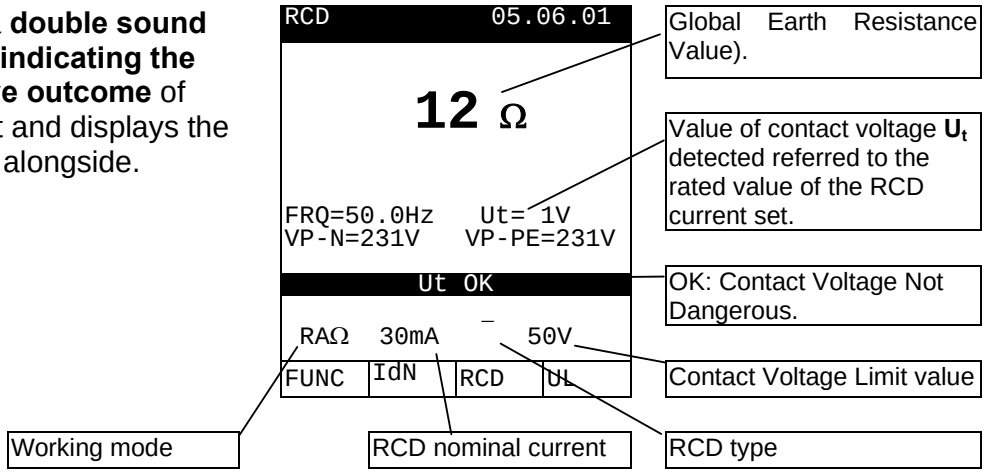
6.3.2.5. Results of "RA⏚" mode

START STOP 4. Press the **START** key **once**: the instrument carries out the test.

CAUTION

Never disconnect the test leads when the message **"MEASURING"** is displayed.

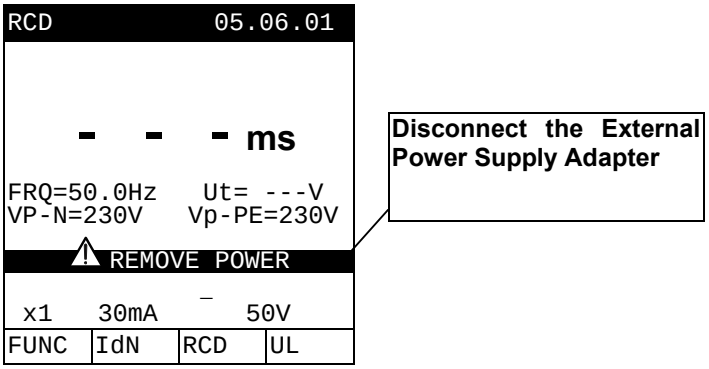
☞ The RCD **must NOT trip** and the instrument emits a **double sound signal indicating the positive outcome** of the test and displays the screen alongside.



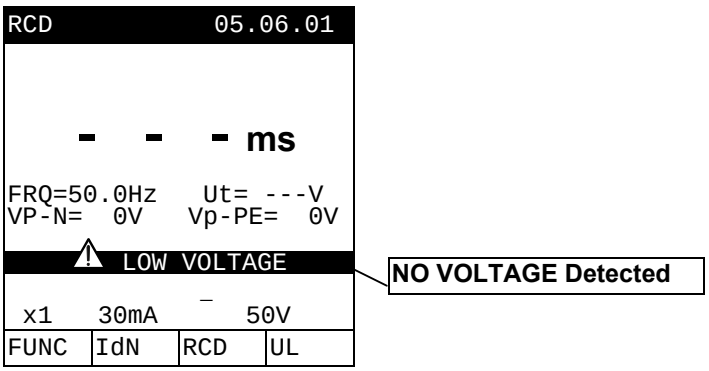
SAVE The test can be stored pressing the **SAVE** key **twice** (according to paragraph 9.1).

6.3.3. RCD Faulty cases
6.3.3.1. Connection troubles

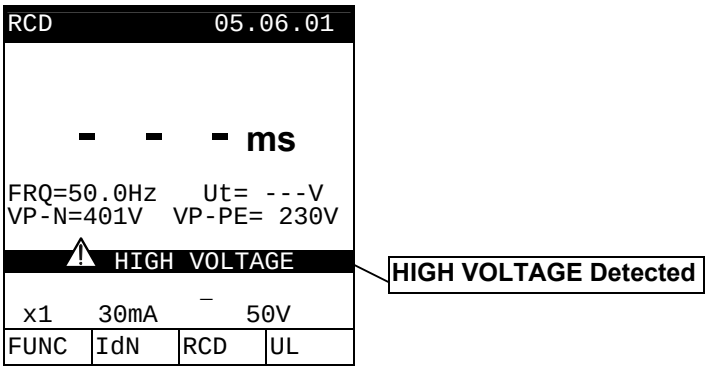
☞ If the instrument detects the External Power supply adapter connected, the instrument will show the message displayed along side.



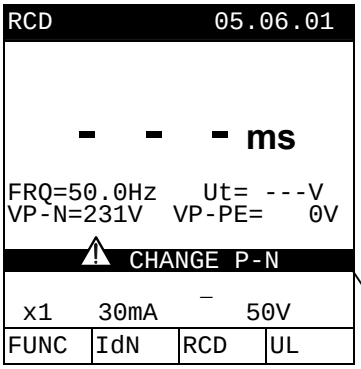
☞ Should the instrument detect that the phase and/or neutral cables are not connected to an installation, screen alongside is displayed when pressing START.



☞ Should the instrument detect a voltage between phase and neutral higher of 250V, for example in case the black cable is connected to an installation phase conductor of a 400V three-phase system, the screen alongside is displayed.

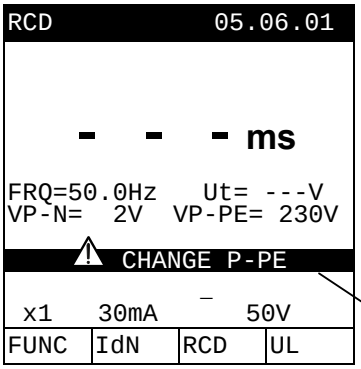


☞ This screen is displayed when the phase conductor has been reverseded with the neutral one.
The instrument does not perform the test.
Exchange the red cable with the black one.
Repeat the test



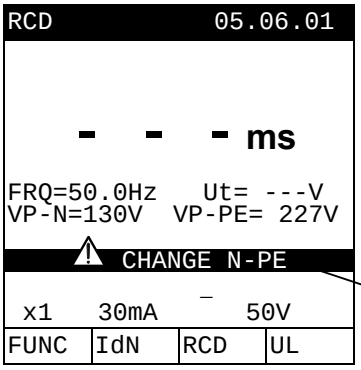
Phase and Neutral Conductors are reversed.

☞ This screen is displayed when the phase conductor has been exchanged with the Protection Conductors.
The instrument does not perform the test.
Reverse the phase to earth connection in the plug or exchange the red cable with the green one.



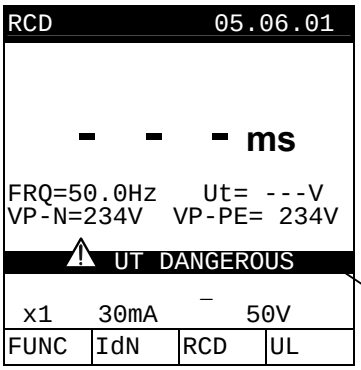
Phase and Protection Conductors are reversed.

☞ This screen is displayed when in a 230V Phase to Phase System the black conductor was reversed with respect to the green one.
The instrument does not perform the test.
Reverse the black and green conductors.



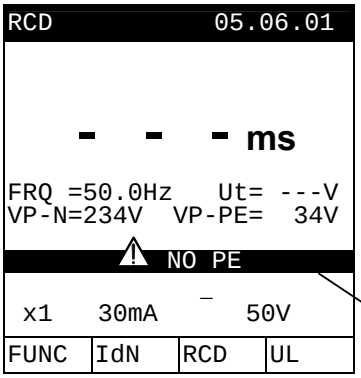
Neutral and Protection Conductors are reversed.

☞ If a contact voltage **U_t higher than the selected limit (U_L)** is detected, the instrument **interrupts** the test and emits **a long sound signal** at the end of the test and displays the screen alongside.



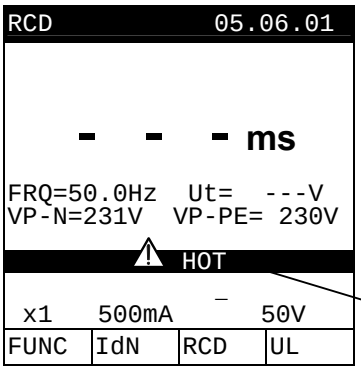
The instrument doesn't detect an efficient protection circuit.

☞ If the instrument detects that the earth cable (green) is not connected, the screen alongside is displayed for 5 seconds then the initial display is back. Check the connections of PE conductor under test.



Message **"NO PE"**: the instrument doesn't detect an efficient protection circuit.

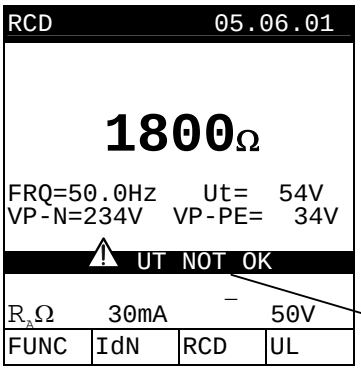
☞ If the instrument gets overheated, tests cannot be carried out and the message alongside is displayed. Wait until the initial screen is back in order to proceed with measurements.



Message "hot": the instrument got overheated.

THE PREVIOUS RESULTS CANNOT BE SAVED.

☞ Using the $R_A\Omega$ function, if a contact voltage **U_t higher than the selected limit (U_L)** is detected the instrument emits **a long sound signal** at the end of the test and displays the screen alongside.

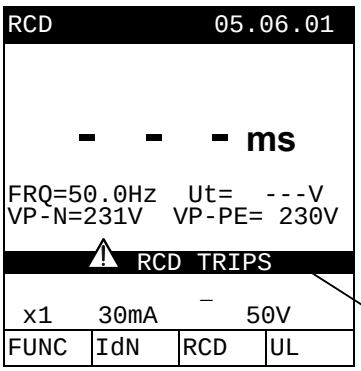


The instrument does not detect an efficient protection circuit.

SAVE The test can be stored pressing the **SAVE** key **twice** (according to paragraph 9.1).

6.3.3.2. RCD tripping "faulty cases"

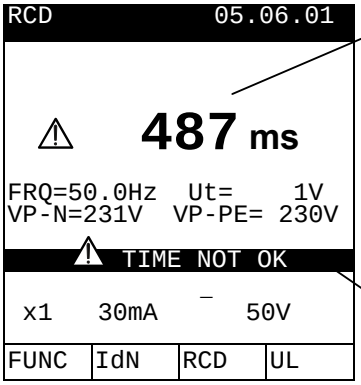
☞ If the RCD trips during the preliminary test performed before the test (independently from the working mode) the instrument displays the screen alongside.



The RCD trips too early. Check if the RCD Nominal Current is correct. Some leakage currents may be present in the installation. Disconnect all the loads connected downstream the RCD.

THE PREVIOUS RESULTS CANNOT BE SAVED.

☞ In the tests MAN x1, x2, x5 and AUTO (during x1 and x5 tests), if the RCD trips to separate the circuit within a time not complying with the limits reported in Table 3, the instrument emits **a long acoustic signal** at the end of the test and displays the values alongside.

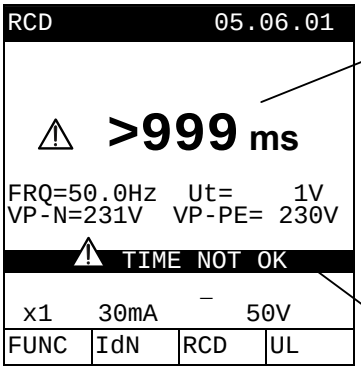


RCD tripping time.

ATTENTION: the tripping time is higher than the standard limit.

SAVE The test can be stored pressing the **SAVE** key **twice** (according to paragraph 9.1).

☞ If the RCD tripping time is higher than the instrument's measuring limits, the instrument emits **a long sound signal** at the end of the test and displays the values alongside.



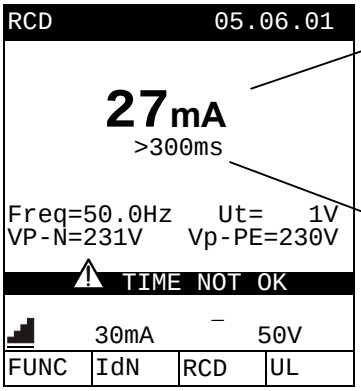
RCD tripping time is bigger than the maximum measurable time (it depends on type of test, see following table).

ATTENTION: the tripping time is higher than the standard limit.

The maximum duration depends on the test type:

Test type	General RCD	Selective RCD
MAN x1 test	999ms	999ms
MAN x2 test	200ms	250ms
MAN x5 test	50ms	160ms
"▟" test	300ms	

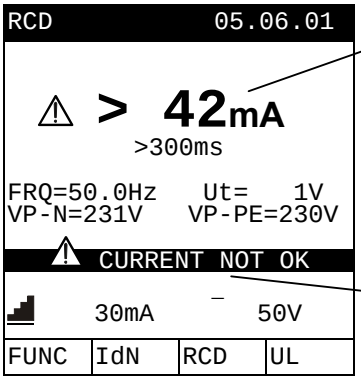
☞ During the ramp ▟ test if the RCD tripping time is higher than the limit, the instrument emits **a long sound signal** at the end of the test and displays the values alongside.



Tripping Current.

Tripping Time exceeding limit value

☞ During the ramp ▟ test if the RCD tripping current is higher than $I_{\Delta n}$ (Type AC) or 1.4 $I_{\Delta n}$ (Type A with $I_{\Delta n}$>10mA) or 2 $I_{\Delta n}$ (Type A with $I_{\Delta n}$≤10mA) , the instrument emits **a long sound signal** at the end of the test and displays the values alongside.



Maximum current generated by the instrument during the test for general RCDs (the value indicated is referred to an AC type 30mA RCD, in this case the maximum current supplied is equal to 1.4x$I_{\Delta N}$

ATTENTION:
The RCD tripping current is higher than the Nominal Value ($I_{\Delta N}$=30mA was set in the example).

SAVE The previous results can be stored pressing the **SAVE** key **twice** (according to paragraph 9.1).

6.4. LOOP ↻: MEASUREMENT OF LINE IMPEDANCE, FAULT LOOP IMPEDANCE, PROSPECTIVE SHORT CIRCUIT CURRENT CALCULATION AND PHASE SEQUENCE INDICATOR

Turn the **switch** on **LOOP** ↻ position.

F1 The **F1** key permits to select one of the following measuring modes:

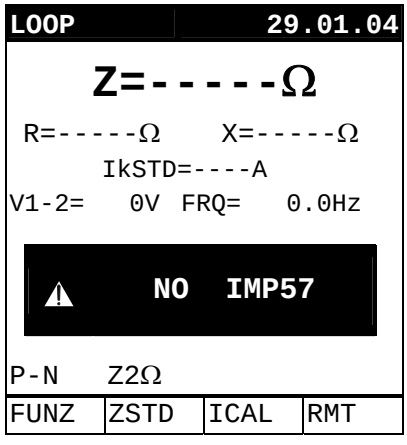
- ☞ Mode "**P-N**" (the instrument measures the impedance between the phase and neutral conductors and calculates the phase to neutral prospective short circuit current).
- ☞ Mode "**P-P**" (the instrument measures the impedance between two phase conductors and calculates the phase to phase prospective short circuit current).
- ☞ Mode "**P-PE**" (the instrument measures the impedance between the phase and protective conductors and calculates the phase to earth prospective short circuit current).
- ☞ Mode "**$R_A\Omega$**" (the instrument measures the impedance between the phase and protective conductors with a test current of 15mA in order to avoid RCD tripping and calculates the phase to earth prospective short circuit current).
- ☞ Mode "↻" (the instrument detects the Phase Sequence in a three-phase system).

CAUTION

Never disconnect the test leads when the message **"MEASURING"** is displayed.

6.4.1. High resolution Impedance measurement (0.1mΩ)

The MARVR2250 model is connectable to an external **optional** accessory (IMP57) useful for high resolution impedance measurement close to a power transformer.
The high Resolution impedance measurement is available inside the **LOOP P-P**, **P-N**, **P-PE** modes by mean **Un/IΔn** key. If you enable the High Resolution Impedance Measurement mode without connecting IMP57 the following screen will be displayed (e.g.: Loop P-N):

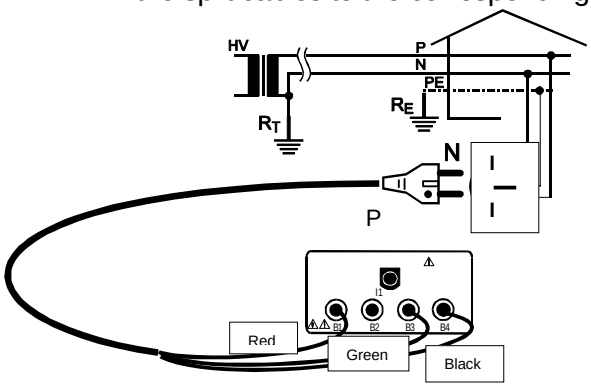


For further details regarding IMP57 use and technical characteristics please refer to IMP57 user's manual or Martindale Electric web site **www.Martindale-Electric.co.uk**.

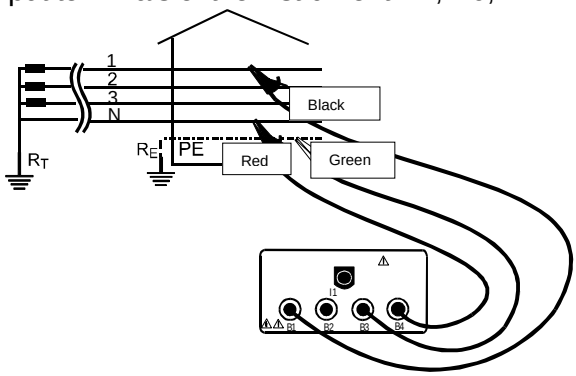
6.4.2. Measurement procedure and results of "P-N" mode

F1

1. Select **P-N** mode by means of the **F1** key.
2. Connect the red, green and Black connectors of the three-terminal mains cable or of the split cables to the corresponding input terminals of the instrument **B1**, **B3**, **B4.**



Instrument connection for P-N test in a 230V single-phase System



Instrument connection for P-N in a 400V three-phase system

3. Connect the mains plug into a 230V 50Hz socket or the crocodiles to the conductors of the three-phase system (see previous pictures).
4. If possible disconnect all low impedance loads downstream the point at which the measurement is to be taken; as such impedances would be in parallel with the line impedance to be measured.

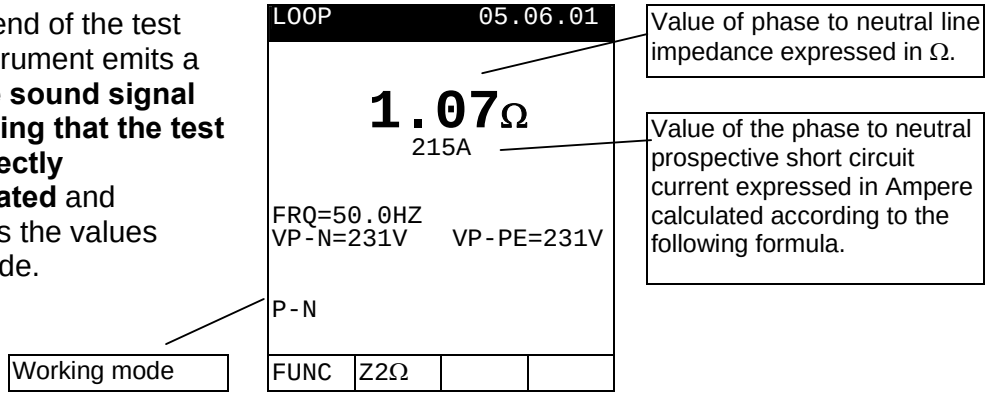
START STOP

5. Press the **START** key. The instrument starts the test.

CAUTION

The measurement in a 230V System, make a test current of 6A approx. This may cause the tripping of magnetic protection switch with nominal value lower than 10A. If necessary perform the test upstream of the switch. Never disconnect the test leads when the message **"MEASURING"** is displayed.

☞ At the end of the test the instrument emits a **double sound signal indicating that the test is correctly terminated** and displays the values alongside.



Formula for calculation of prospective short circuit current:

$$I_{CC} = \frac{U_N}{Z_{PN}}$$

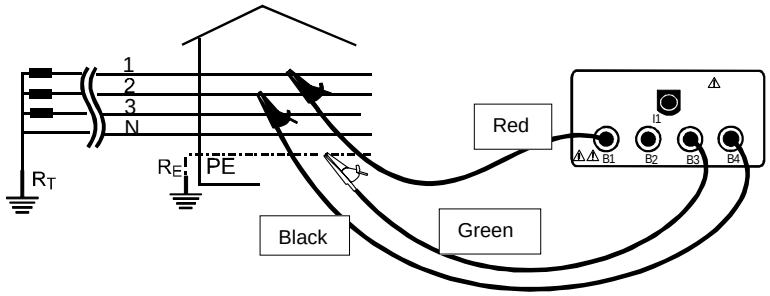
Where U_N = Nominal phase to neutral voltage = 127 if $V_{meas} \leq 150$
230 if $150V < V_{meas} \leq 250$

SAVE This result can be stored pressing the **SAVE** key **twice** (according to paragraph 9.1).

6.4.3. Measurement procedure and results of "P-P" mode

F1

1. Select **P-P** mode by means of the **F1** key.
2. Connect the Red, Green and Black connectors of the three-terminal mains cable or of the split cables to the corresponding input terminals of the instrument **B1**, **B3**, **B4**



Instrument connection for P-P test in a 400V three-phase system

3. Connect the mains plug into a 230V 50Hz socket or the crocodiles to the conductors of the three-phase system (see previous pictures).
4. If possible disconnect all low impedance loads downstream the point at which the measurement is to be taken; as such impedance would be in parallel with the line impedance to be measured.

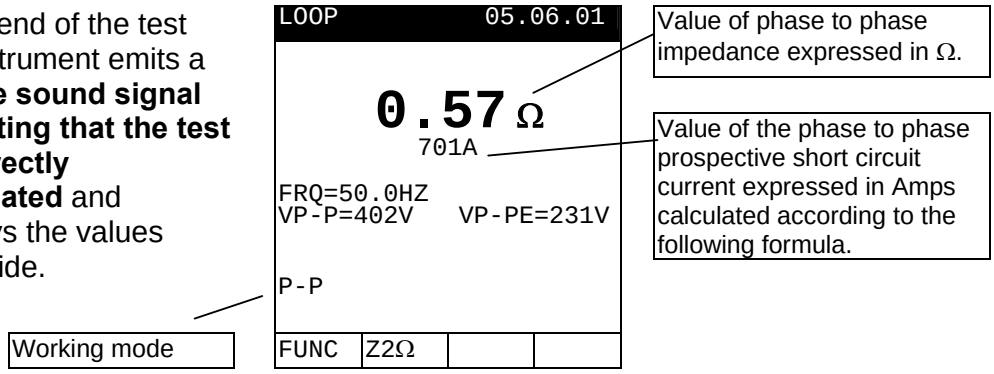
START STOP

5. Press the **START** key. The instrument starts the test.

CAUTION

The P-P measurements in a 400V system make a test current of 11.5A approx. This may cause the tripping of magnetic protection switch with nominal value lower than 10A. If necessary perform the test upstream of the switch. Never disconnect the test leads when the message **"MEASURING"** is displayed.

☞ At the end of the test the instrument emits a **double sound signal indicating that the test is correctly terminated** and displays the values alongside.



Formula for calculation of prospective short circuit current:

$$I_{CC} = \frac{U_N}{Z_{PP}}$$

Where U_N= phase to phase voltage

127 if $V_{meas} \leq 150$
230 if $150V < V_{meas} \leq 260$
400 if $V_{meas} > 260$

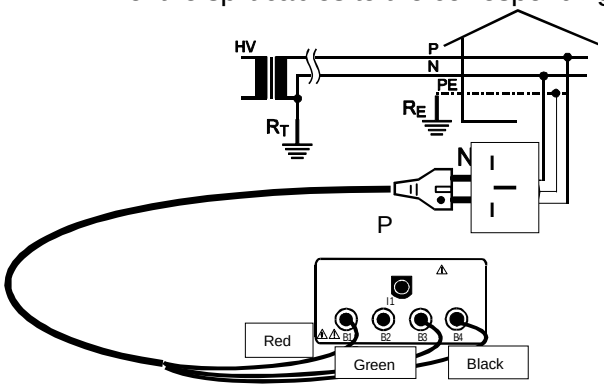
SAVE

This result can be stored pressing the **SAVE** key **twice** (according to paragraph 9.1).

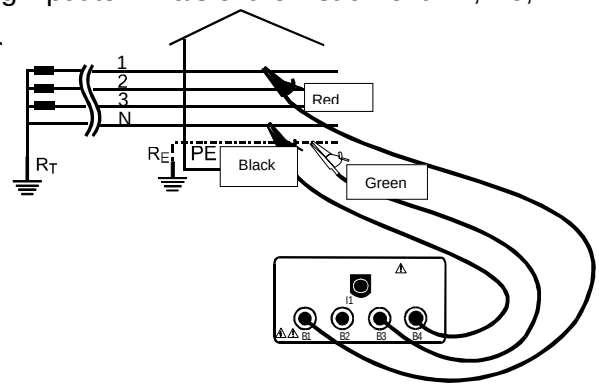
6.4.4. Measurement procedure and results of "P-PE" mode

F1 1. Select **P-PE** mode by means of the **F1** key.

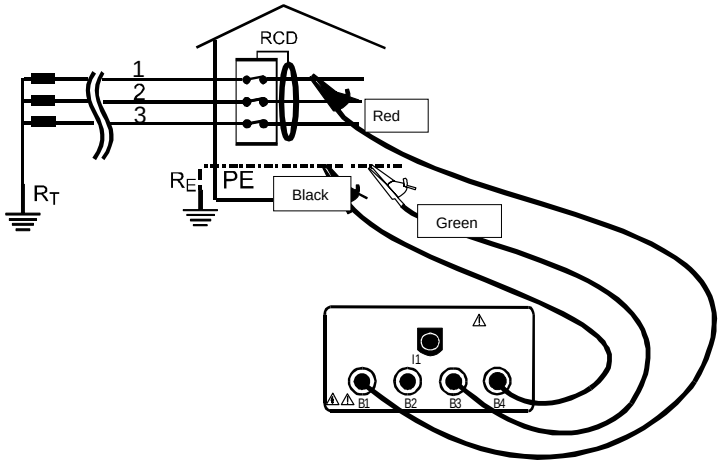
2. Connect the Red, Green and Black connectors of the three-terminal mains cable or of the split cables to the corresponding input terminals of the instrument **B1**, **B3**, **B4**.



Instrument connection for P-PE test in a 230V single-phase System



Instrument connection for P-PE in a 400V three-phase system



Instrument connection for P-PE in a 400V three-phase system without Neutral conductor

3. Connect the mains plug into a 230V 50Hz socket or the crocodiles to the conductors of the three-phase system (see previous pictures).
4. The key **F4** permits to select one of the following **limit values for the contact voltage** (which can be shown cyclically when pressing the key):
   - ☞ 50V (default).
   - ☞ 25V.

START STOP 5. Press the **START** key **once** to execute a test injecting a current <u>in phase with positive half wave of the</u> voltage.
Press the **START** key **twice** to execute a test injecting a current in <u>phase with negative half wave of the voltage.</u>

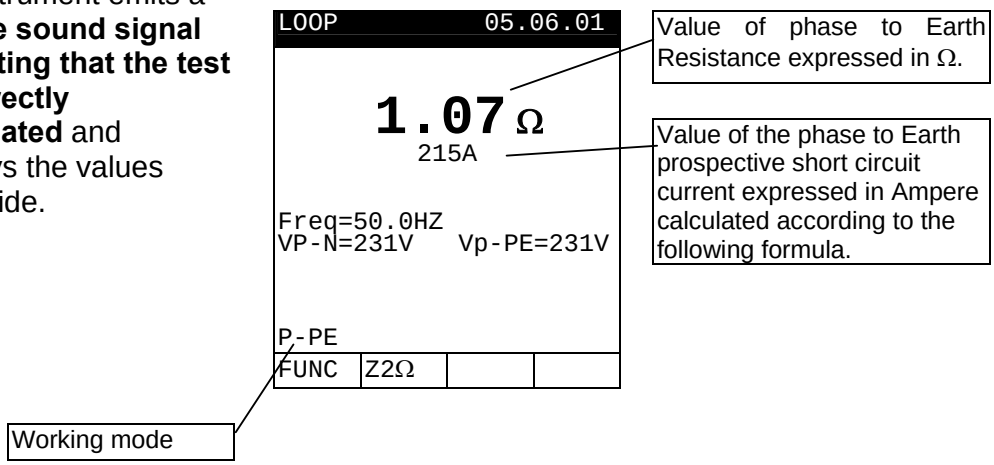
CAUTION

The P-PE measurement in a 230V System makes a test current of 6A approx. This may cause the tripping of magnetic protection switch with nominal value lower than 10A and **will cause the tripping of RCD device**. If necessary perform the test upstream of the switch or RCD.

CAUTION

Never disconnect the test leads when the message **"MEASURING"** is displayed.

☞ At the end of the test the instrument emits a **double sound signal indicating that the test is correctly terminated** and displays the values alongside.



Formula for calculation of prospective short circuit current:

$$I_{CC} = \frac{U_N}{Z_{PE}}$$

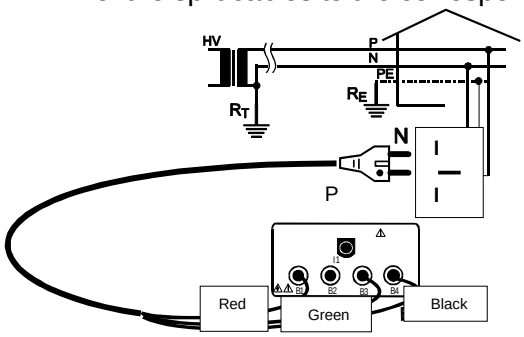
Where U_N = Nominal phase to neutral voltage = 127 if $V_{meas} \leq 150$
230 if $150V < V_{meas} \leq 250$

SAVE This result can be stored pressing the **SAVE** key **twice** (according to paragraph 9.1).

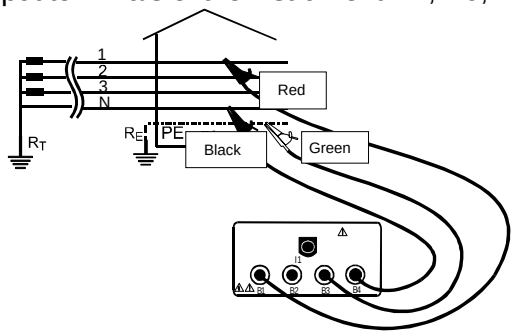
6.4.5. Measurement procedure and results of " R_A⏚" mode

F1

1. Select R_A⏚ mode by means of the **F1** key.
2. Connect the Red, Green and Black connectors of the three-terminal mains cable or of the split cables to the corresponding input terminals of the instrument **B1**, **B3**, **B4**.



Instrument connection for P-PE test in a 230V single-phase System



Instrument connection for P-PE in a 400V three-phase system

3. Connect the mains plug into a 230V 50Hz socket or the crocodiles to the conductors of the three-phase system (see previous pictures).
4. If possible disconnect all low impedance loads downstream of the point at which the measurement is to be taken; as such impedance would be in parallel with the line impedance to be measured.
5. The key **F4** permits to select one of the following **limit values for the contact voltage** (which can be shown cyclically when pressing the key):
   - ☞ 50V (default)
   - ☞ 25V.

START STOP

6. Press the **START** key **once** to execute a test with "**0°**" test current.

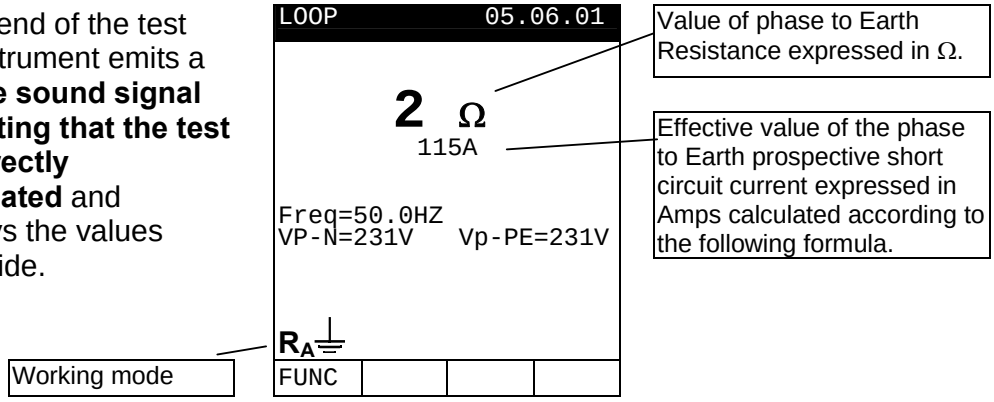
   or

   Press the **START** key **twice** to execute a test with "**180°**" test current.

CAUTION

The R_A⏚ measurement make a test current of 15mA. This may cause the tripping of 10mA. If necessary perform the test upstream of the switch. Never disconnect the test leads when the message **"MEASURING"** is displayed.

☞ At the end of the test the instrument emits a **double sound signal indicating that the test is correctly terminated** and displays the values alongside.



Formula for calculation of prospective short circuit current: $I_{CC} = \frac{U_N}{Z_{PE}}$

Where U_N = Nominal phase to neutral voltage = 127 if $V_{meas} \leq 150$
230 if $150V < V_{meas} \leq 250$

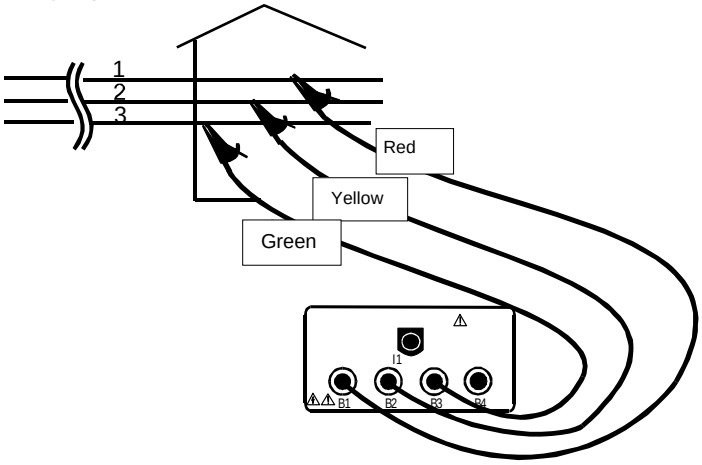
SAVE

This result can be stored pressing the **SAVE** key **twice** (according to paragraph 9.1).

6.4.6. Measurement procedure and results of "↻" mode

F1 1. Select ↻ mode by means of the **F1** key.

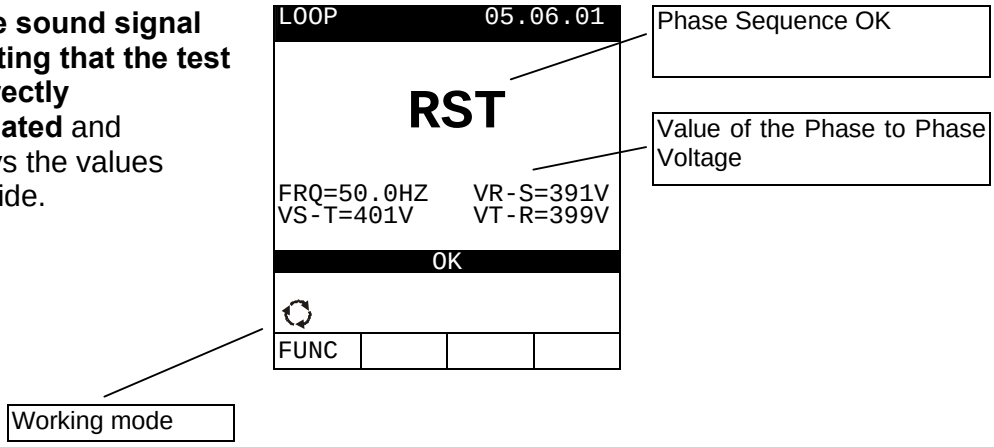
2. Connect the Red, Yellow and Green connectors of the split cables to the corresponding input terminals of the instrument **B1**, **B2**, **B3**.



Instrument connection for Phase Sequence Detection in a 400V three-phase system

START STOP 3. Press the **START** key to execute a test.

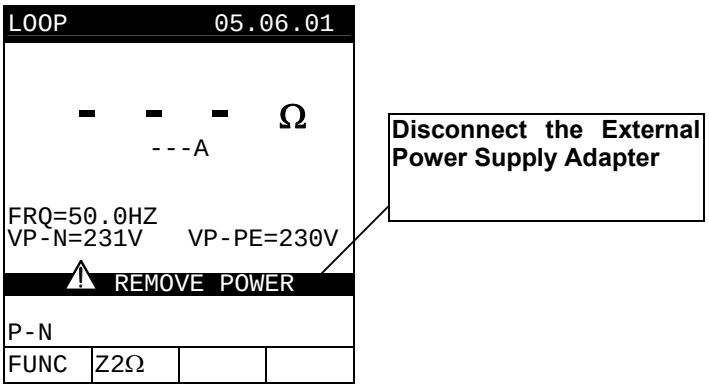
☞ At the end of the test the instrument emits a **double sound signal indicating that the test is correctly terminated** and displays the values alongside.



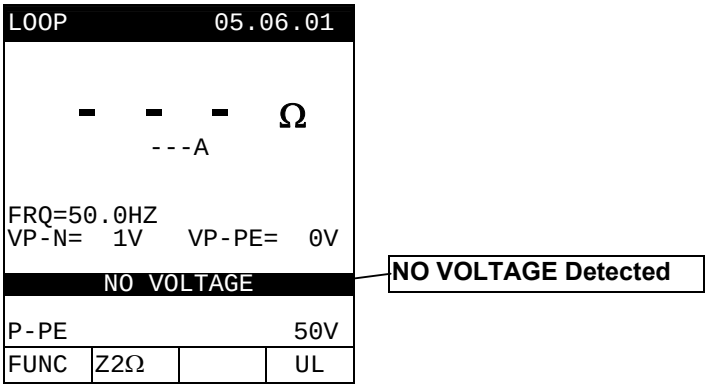
SAVE This result can be stored pressing the **SAVE** key **twice** (according to paragraph 9.1).

6.4.7. LOOP Faulty Cases

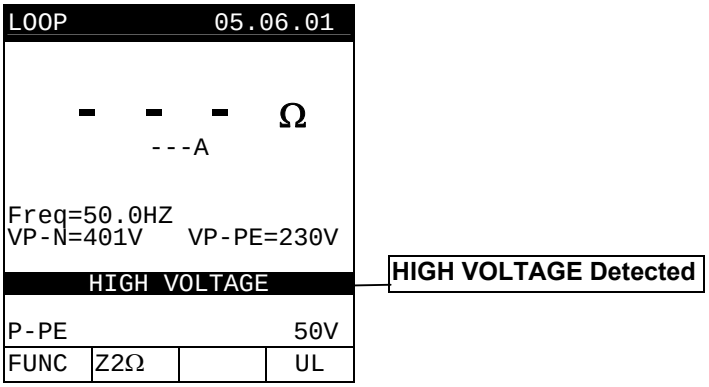
☞ If the instrument detects the External Power supply adapter connected, the instrument will show the message displayed along side.



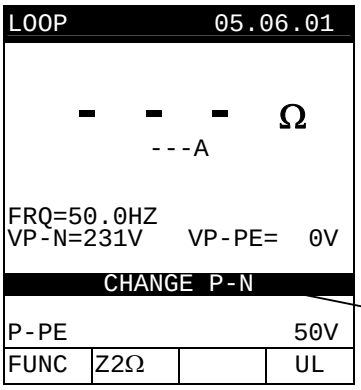
☞ Should the instrument detect that the phase and/or neutral cables are not connected to an installation, the screen alongside is displayed when pressing START.



☞ Should the instrument detect a voltage between phase and neutral higher of 250V, for example in case the black cable is connected to an installation phase conductor of a 400V three-phase system, the screen alongside is displayed.

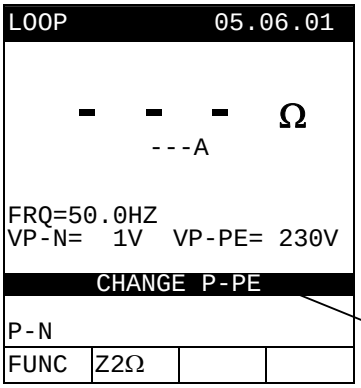


☞ This screen is displayed when the phase conductor has been reversed with the neutral one.
The instrument does not perform the test.
Exchange the red cable with the black one.



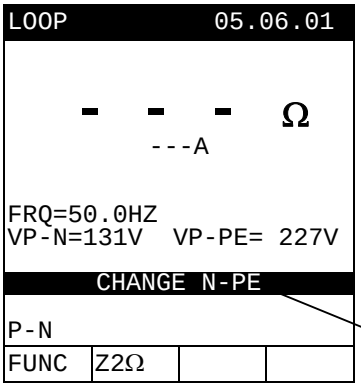
Phase and Neutral Conductors are reversed.

☞ This screen is displayed when the phase conductor has been exchanged with the Protection Conductors.
The instrument does not perform the test.
Exchange the red cable with the green one.



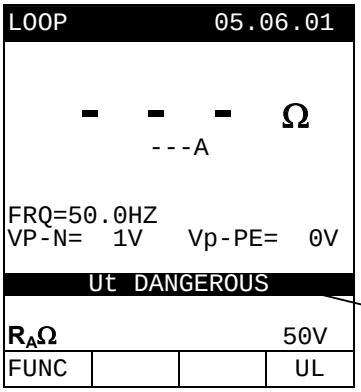
Phase and Protection Conductors are reversed.

☞ This screen is displayed when in a 230V Phase to Phase System the black conductor was reversed with respect to the green one.
The instrument does not perform the test.
Reverse the black and green conductors.



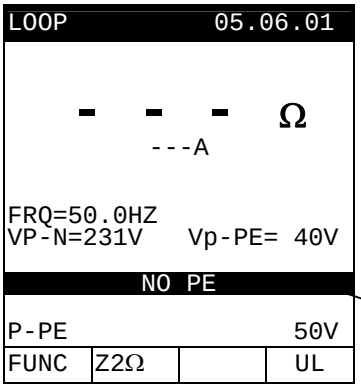
Neutral and Protection Conductors are reversed.

☞ If a contact voltage **U_t higher than the selected limit (U_L)** is detected the instrument interrupts the test and emits **a long sound signal** at the end of the test and displays the screen alongside.



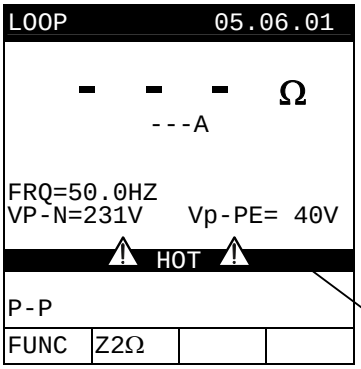
Message **"Ut"**: the instrument doesn't detect an efficient protection circuit.

☞ Should the instrument detect an Earth Resistance extremely high to consider no presence of PE conductor or Earth installation ones, it shows the message along side. Please check the efficiency of PE conductor and Earth installation.



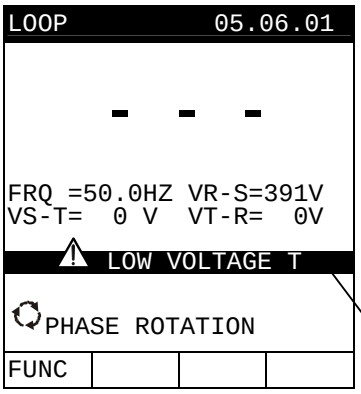
Message **"NO PE"**: the instrument doesn't detect an efficient protection circuit.

☞ If the instrument gets overheated, tests cannot be carried out and the message alongside is displayed. Wait until the initial screen is back in order to proceed with measurements.

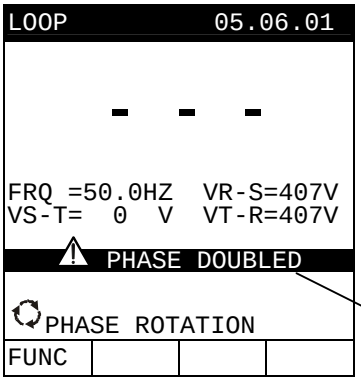


Message "hot": the instrument got overheated.

☞ Using the "↻" mode, if a Phase to Phase voltage is lower than 100V, the instrument displays the screen indicated alongside.

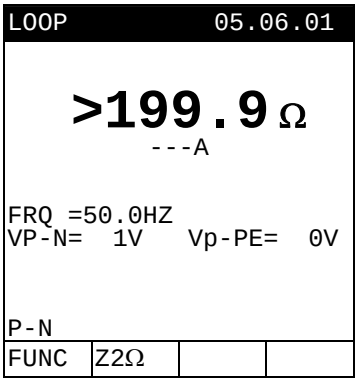


☞ Using the "↻" mode, if the instrument detects two phases connected together displays the screen indicated alongside.



<u>THE PREVIOUS RESULTS CANNOT BE SAVED</u>.

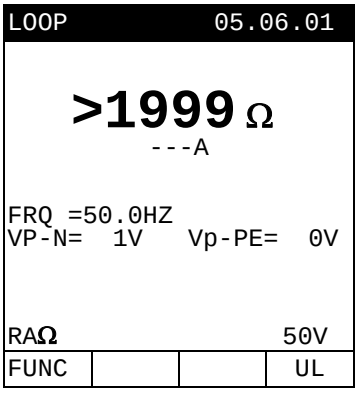
☞ In the mode **P-P**, **P-N** mode the instrument carries out the test and detects a **resistance to be higher than 199.9Ω**, the screen alongside is displayed.



Message ">199.9" means that the Resistance measured is higher than the maximum measurable

SAVE This result can be stored pressing the **SAVE** key **twice** (according to paragraph 9.1).

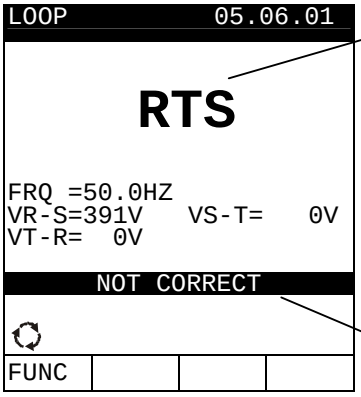
☞ In the mode **P-PE**, **R_AΩ** mode the instrument carries out the test and detects a **resistance to be higher than 1999Ω**, the screen alongside is displayed.



Message ">1999" means that the Resistance measured is higher than the maximum measurable

SAVE This result can be stored pressing the **SAVE** key **twice** (according to paragraph 9.1).

☞ In the ↻ mode, if the voltage of one or more phases is too low, one or more phases has a low voltage the instrument will show a screen similar to the one alongside.

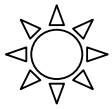


Phase Sequence not correct

Message “LOW Voltage Phase T”: means that Phase T has a low voltage value. Similar message for Phase R and S.

SAVE This result can be stored pressing the **SAVE** key **twice** (according to paragraph 9.1).

6.5. EARTH: SOIL RESISTANCE AND RESISTIVITY MEASUREMENTS



Turn the **switch** to the **EARTH** position.

F1

The **F1** key permits to select one of the following measuring modes (which can be shown cyclically when pressing the key):

- ☞ Mode "2-W" (the instrument measures the resistance between 2 points).
- ☞ Mode "3-W" (the instrument measures the resistance using two auxiliary earth rods).
- ☞ Mode "ρ" (the instrument measures the ground resistivity).

At the end of each test, instrument shows automatically the average value of Earth Resistance or Earth Resistivity calculated on the base of any measured values until that moment.

F2

F2 key clear average value of Earth Resistance or Earth Resistivity and the counter of executed Resistance measures.

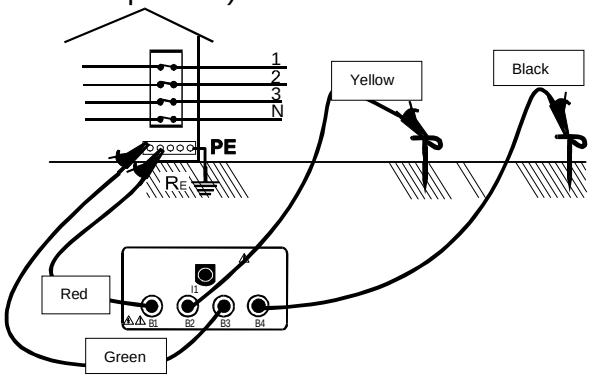
CAUTION

Never disconnect the test leads from the circuit under test when the message **"MEASURING"** is displayed

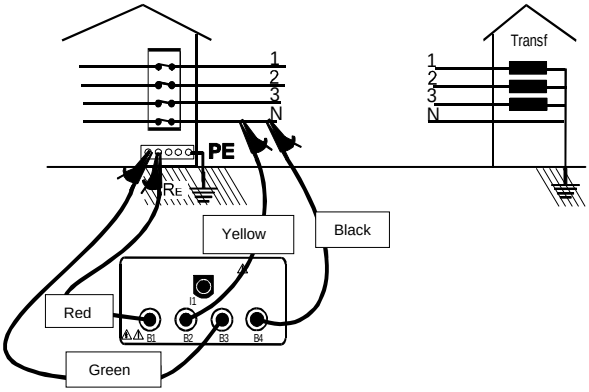
6.5.1. Measurement procedure and results of "2-W"and "3-W" mode

F1

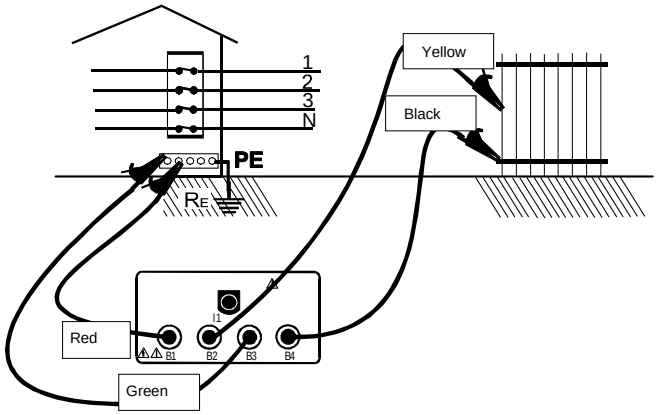
1. Select "**2-W**" or "**3-W**" Earth measurement mode by means of the **F1** key.
2. Connect the Red, Yellow, Green and Black cables to the corresponding input terminals of the instrument **B1**, **B2**, **B3**, **B4** (see possible connections in the following pictures).



Connection for 3 point Earth resistance measurement



Connection for 2 point Earth Resistance measurement

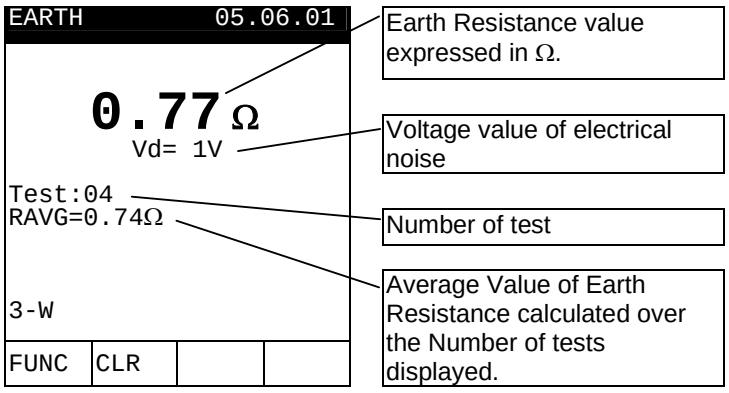


Connection for measuring the resistance between an extraneous conductive part and the earth system

START STOP

3. Press the **START** key. The instrument starts the test.

☞ At the end of the test the instrument emits a **double sound signal indicating that the test is correctly terminated** and displays the values alongside.



4. The instrument will show automatically the Average value of the Earth resistance calculated over the tests performed. Press **F2** to RESET this value and the number of Tests.

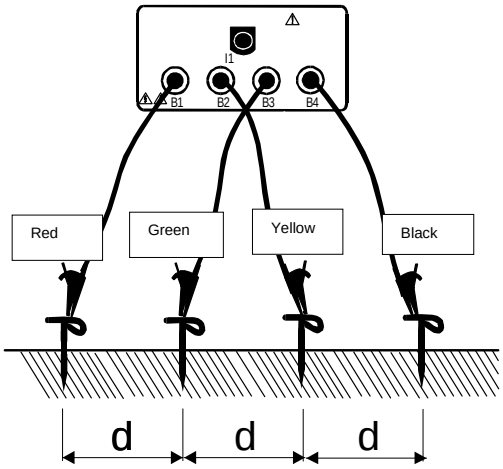
SAVE

This result can be stored pressing the **SAVE** key **twice** (according to paragraph 9.1).

6.5.2. Measurement procedure and results of "ρ" mode

F1

1. Select ρ measurement mode by means of the **F1** key.
2. Select the distance **d** between the earth rods by means the **F3** and **F4** keys.
3. Connect the 4 Red, Green, Yellow and Blue connectors of the single cables in the corresponding input terminals of the instrument **B1**, **B2**, **B3**, **B4**.

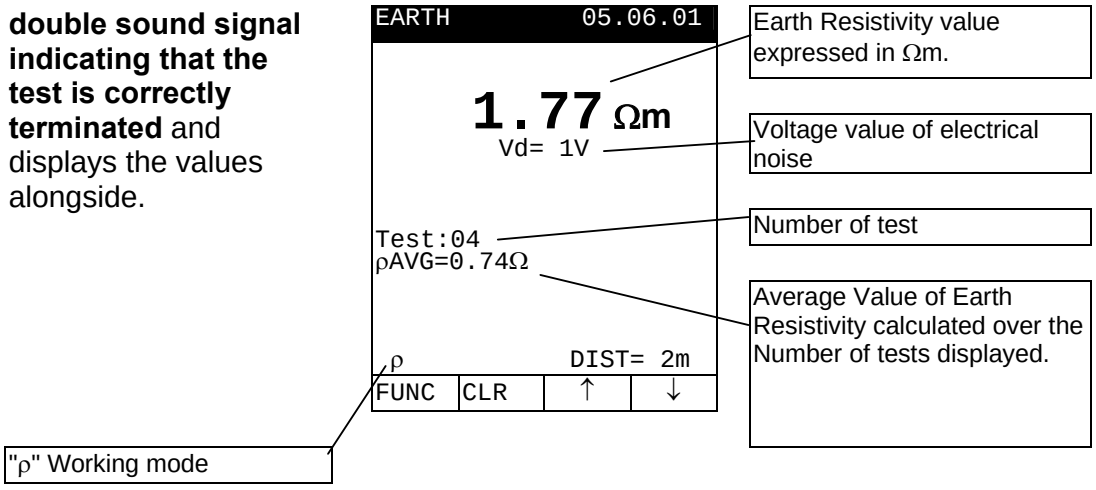


Instrument connection for Earth resistivity measurement

START STOP

4. Press the **START** key. The instrument starts the test.

☞ At the end of the test the instrument emits a **double sound signal indicating that the test is correctly terminated** and displays the values alongside.



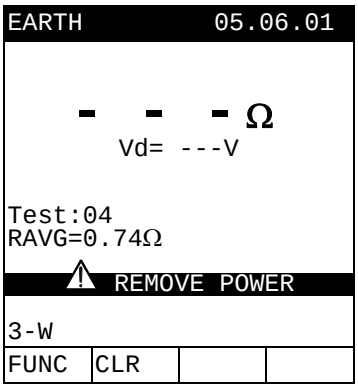
5. The instrument will show automatically the average value of the Earth Resistivity calculate over the tests performed. Press **F2** to RESET this value and the number of Test.

SAVE

This result can be stored pressing the **SAVE** key **twice** (according to paragraph 9.1).

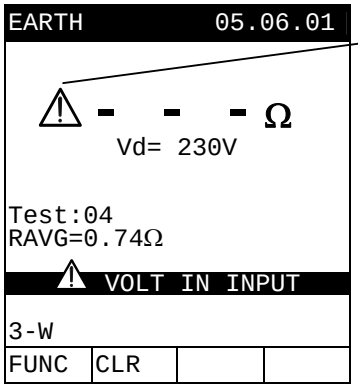
6.5.3. "2-W", "3-W" and "ρ" faulty cases

☞ If the instrument detects the External Power supply adapter connected to the instrument it will show the message displayed along side.



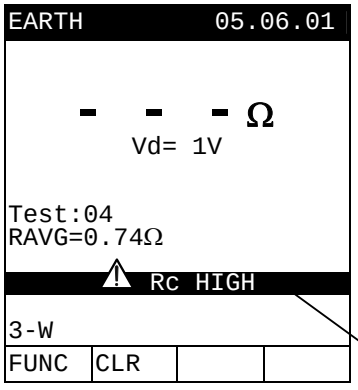
Disconnect the External Power Supply Adapter

☞ If the Instrument detects a voltage value higher than 5V the instrument will show the screen displayed alongside.



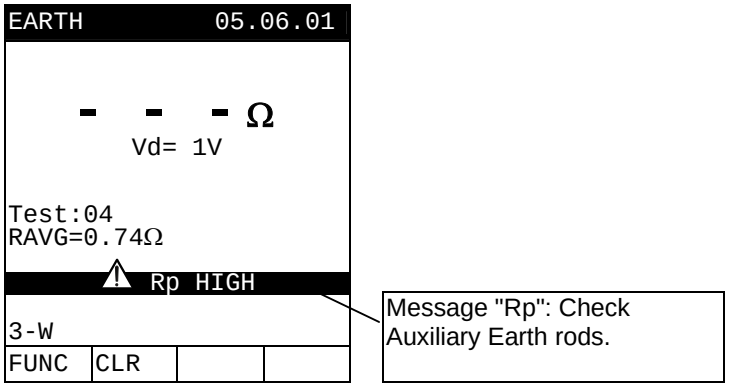
Warning symbol: Voltage noise in input.

☞ The message "**Rc high**" indicates that the instrument cannot flow the minimum current necessary for measurement. Check that the terminals are correctly connected and the Auxiliary earth rod connected to B4 (black conductor) has not been inserted in a pebbly or poor conductive ground. If necessary pour some water around the rod.

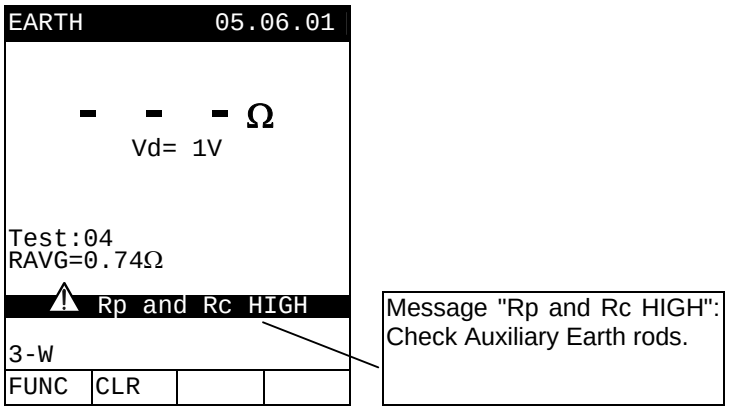


Message "Rc": Check Auxiliary Earth rods.

- The message "**Rp high**" indicates that the instrument cannot measure correctly the Voltage from Auxiliary Earth rod and cannot flow the minimum current for measurement. Check that the terminals are correctly connected and the Auxiliary earth rod connected to B2 (yellow conductor) has not been inserted in a pebbly or poor conductive ground. If necessary pour some water around the rod.

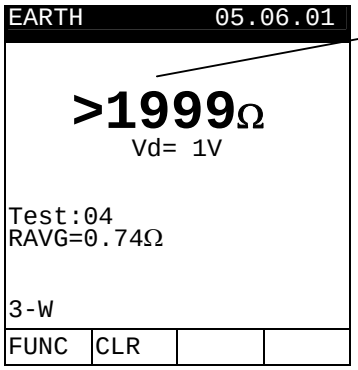


- The message "**Rp and Rc high**" indicates that the instrument cannot measure correctly the Voltage from Auxiliary Earth rod and cannot flow the minimum current for measurement. Check that the terminals are correctly connected. Check if the Auxiliary earth rod connected to B2 (yellow conductor) and B4(black conductor) has not been inserted in a pebbly or poor conductive ground. If necessary pour some water around the rod.



<u>THE PREVIOUS RESULTS CANNOT BE SAVED</u>.

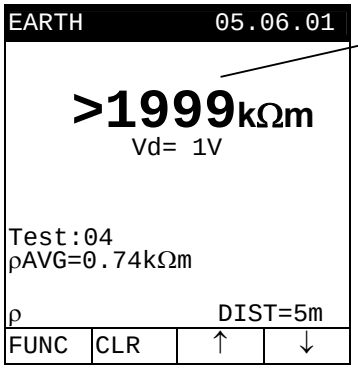
☞ If the Instrument detects a Resistance value higher than 1999Ω, the instrument will display the screen alongside.



Message ">1999" means that the resistance value is higher than the maximum measurable.

SAVE This result can be stored pressing the **SAVE** key **twice** (according to paragraph 9.1).

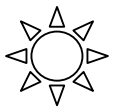
☞ If the Instrument detects a resistivity value higher than 1999kΩ, the instrument will display the screen alongside.



Message ">1999" means that the resistivity value is higher than the maximum measurable.

SAVE This result can be stored pressing the **SAVE** key **twice** (according to paragraph 9.1).

7. AUX: MEASUREMENT WITH EXTERNAL PROBES



Turn the **switch** on **AUX** position.

The **F4** function key undertakes the following operations:

F4

☞ Pressing this key the instrument shows one of the following working modes displayed cyclically:

- ✓ Leakage Current (mA), supported by Flexible Clamp.
- ✓ NOTE that other Environmental Parameters (°C, °F, HR%, m/s, mV, Lux) and Sound Level Measurement are not supported.

The "**Leakage Current**" mode allows the following operations:

- ✓ **Display in real time** the values coming from External Flexible Clamp.
- ✓ **Memorize** the values displayed (pressing SAVE key).
- ✓ **Record** (pressing the **START** key after a proper setting) an Input signal coming from the External Flexible Clamp. **It will be possible to analyse the recorded data ONLY by transferring the data to a PC.**
- ✓ **Record** (pressing the **START** key) an Input signal coming from an External Flexible Clamp, using "**Typical Configurations**" with pre-programmed parameters inside meter (see paragraph 7.2.2). **It will be possible to analyse the recorded data ONLY by transferring the data to a PC.**

CAUTION

Please note the difference between **memorize** and **record**: the former means that the instrument stores in the memory only the actual values displayed while the latter means that you want to store the course of the input signals during a recording time (typically long).

7.1. LEAKAGE CURRENT: REAL TIME MEASUREMENT

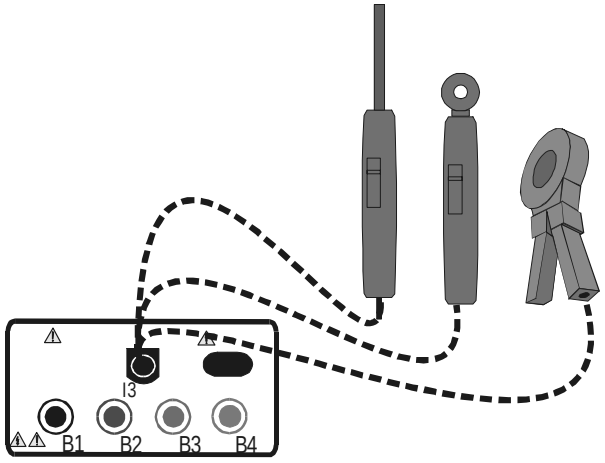
This working mode allows the user to perform real time measurement and recording of Leakage Current, using the External Flexible Clamp.

F4 1. Press this key to access to "**AUX**" mode.

F1 2. Pressing this function key you will change the measuring unit of the instrument's input. The following possibilities will be displayed cyclically:

- - -	(Instrument's input disabled)
mA	(Leakage current)
Others	(not supported)

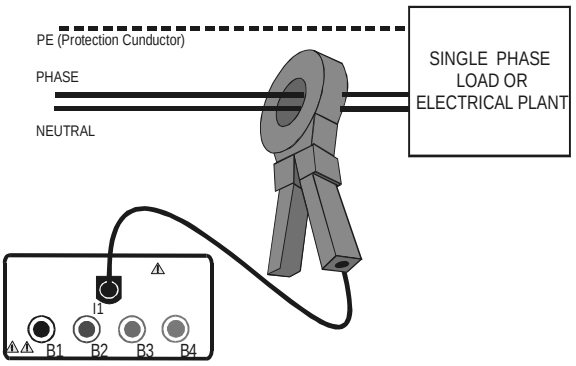
3. Connect the External Flexible Clamp to the In1 instrument's input.
4. Check if the selector on the probe or clamp is adjusted according to the range set in the instrument. Both ranges must be set to the same value.



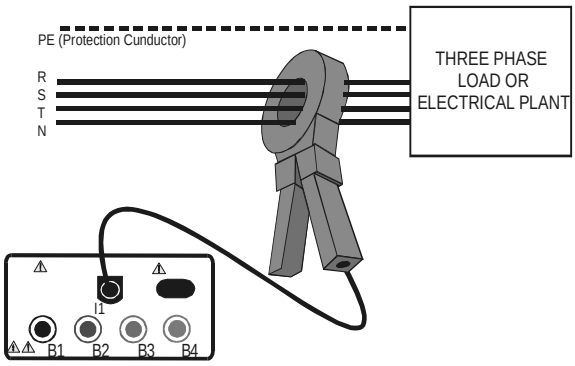
Example of External probes connections

CAUTION

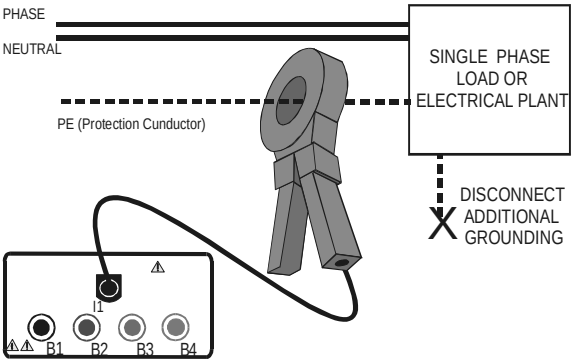
The OFF position of some probes sends to probe's output the Battery voltage (approx 9V which is over the expected full scale). This could influence the measurement of the other instrument's inputs. So NEVER leave connected to instrument probes with the Selector placed in OFF position.



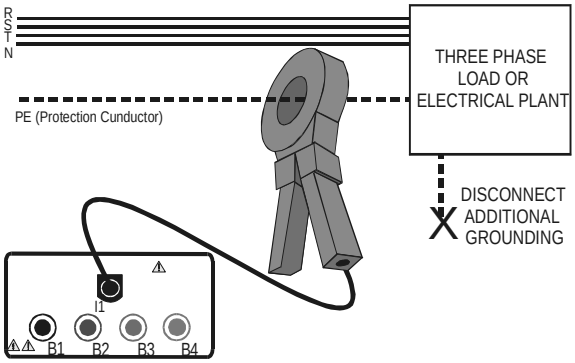
Indirect Leakage Current measurement in a single phase system



Indirect Leakage Current measurement in a three phase system



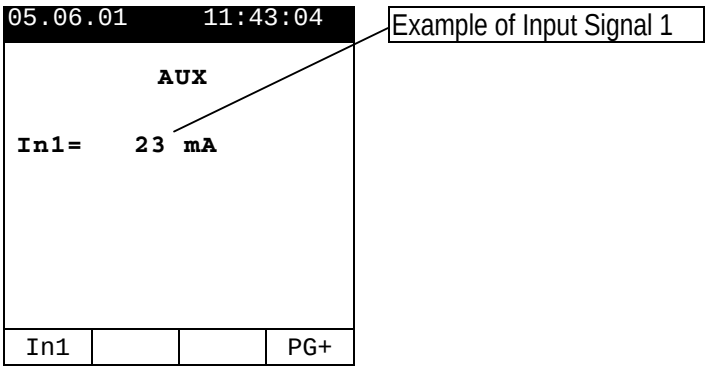
Direct Leakage Current measurement in a single phase system



Direct Leakage Current measurement in a three phase system

5. The Instrument shows in real time the values present at the inputs.

☞ Example of screen.



HOLD ENTER

6. Press this key to enable/disable the HOLD function (updating interruption of the displayed data). When the HOLD function is enabled, the word HOLD is displayed. This key is disabled during a recording. It's not possible to run a recording if this function is enabled.

SAVE

7. The displayed result can be stored pressing the **SAVE** key **twice** (according to paragraph 9.1).

7.2. LEAKAGE CURRENT: RECORDING

Before starting a recording we recommend the user checks that **real time values** are correct.
For this purpose follow the measurement procedure described in paragraph 7.1.

In addition it's fundamental that Instrument settings correspond to the accessories in use.
For this we recommend the user checks the instrument's setting before executing an AUX recording.
To this purpose please check the RECORDER CONFIG settings.

- ☞ **MENU**: to enter in the **MENU** mode and change the instrument settings. It's not possible to enter the configuration MENU during a recording or an energy measurement.
- ☞ **START/STOP**: to record the **selected parameters** according to the instrument's settings (see chapter 10).

7.2.1. AUX Basic setting: RECORDER CONFIG

Place the rotary switch in the **AUX** position, press the **MENU** key, using the **F1**/**F2** keys select the **RECORDER CONFIG** item and press the **ENTER** Key.

CAUTION

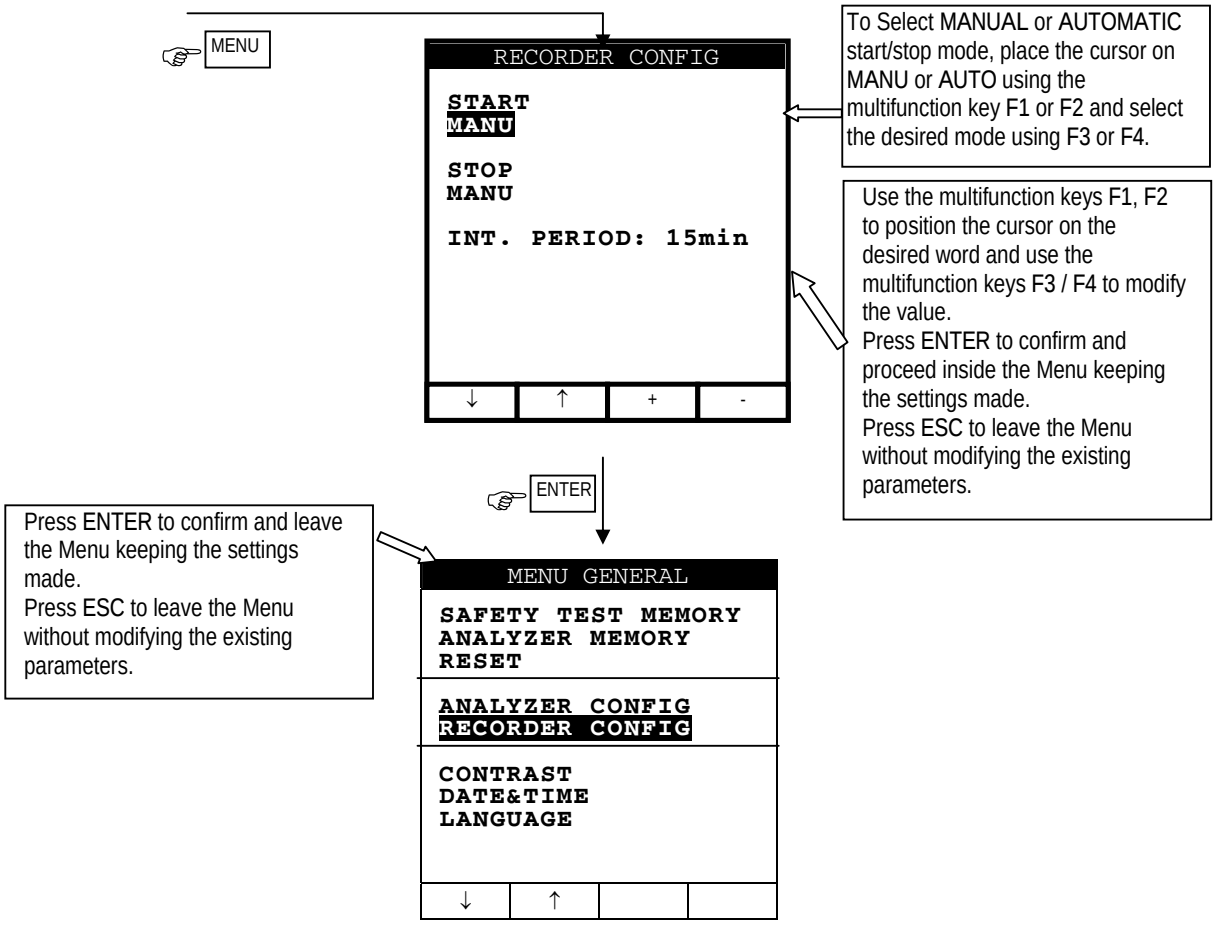
It's not possible to enter the MENU during a recording or a Real Time Energy measurement.

Inside **RECORDER CONFIG** mode it's possible to execute the following operations:

- Setting of Start/Stop recording mode (AUTO or MANUAL) and the date/hour of Start/Stop (in AUTO mode).
- Setting of Integration Period (see paragraph 16.13.1) selectable **from 5 sec to 60 min**

Press **ENTER** to confirm each setting or **ESC** to escape from setting and exit from RECORDER CONFIG menu.

The various pages of the "**RECORDER CONFIG**" can be schematised as follows overleaf:



The following table shows the description of each function inside the RECORDER CONFIG menu:

Function	Description	Advised settings
START:MAN	The recording of all the selected parameters will start at 00 seconds after pressing **START/STOP**.	☺
STOP:MAN	The recording of all the selected parameters will be interrupted manually by pressing **START/STOP**.	☺
START:AUTO STOP:AUTO	The recording of all the selected values will be started / interrupted at the set dates and times. In order to start the recording the user will have to press START/STOP to set the instrument in Stand-by mode until the start date and time previously set..	
INT. PERIOD	The value of this parameter determines every how many seconds the values of **the selected parameters** will be memorised (see paragraph 16.13.1). Available choices: 5sec,10sec,30sec,1min, 2min 5min, 10min, 15min, 30min, 60min.	**15min** ☺

For eventual messages displayed see Appendix 1 – MESSAGES DISPLAYED

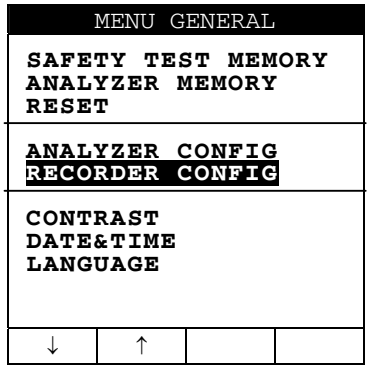
7.2.2. RECORDING: setting of Typical Configurations

The following "**Typical Configurations**" are selectable via RECORDER CONFIG menu:

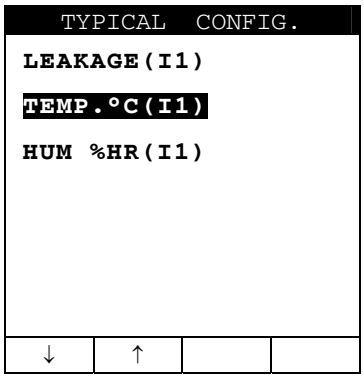
Standard Configuration	Description
LEAKAGE (I1)	Setting of measuring and recording mode of **Leakage current** on I1 channel.

To activate the above configuration, follow this procedure:

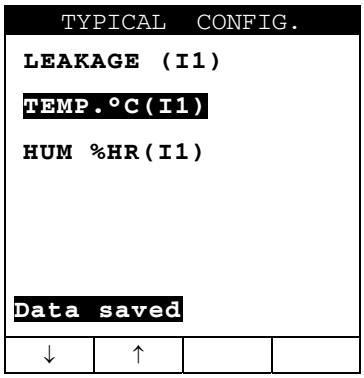
1. Turn the rotary switch to "**AUX**".
2. Press **MENU** key. Use the **F1** key to display the screen below:



3. Press **MENU** key again. The instrument displays a screen as shown below (picture on the left). In this way it is possible to select the desired configuration on I1 channel with **F1** or **F2** key. NOTE that TEMP and HUMIDITY are not supported.



Configuration selection



Confirmation configuration selection

4. Press **ENTER** key. The instrument displays the message "**Data saved**" for a while to confirm the desired configuration (see above picture on the right). The instrument will return to the measuring mode and you can start recording by pressing **START/STOP** key.

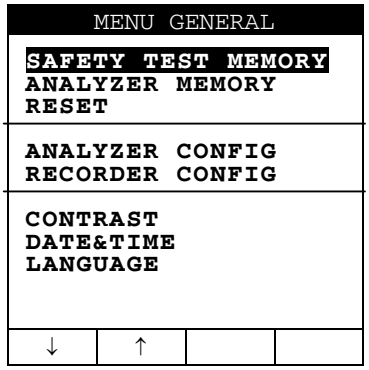
8. ANALYSER

This function allows the following operations:

- ✓ **Display in real time** the electrical parameters of a single phase system (with and without neutral wire) and the harmonic analysis of voltage and current.
- ✓ **Conduct a direct Energy measurement** (without memorizing).
- ✓ **Memorize** (pressing **SAVE** key) the sampled values of the Parameters present at the instrument input generating a "Smp" record inside the instrument memory. **It will be possible to analyse the memorized data ONLY by transferring the data to a PC.**
- ✓ **Record simultaneously** (pressing the **START** key after a proper setting): RMS values of voltage, current, corresponding harmonics, active, reactive and apparent powers, power factors and cosφ, active, reactive and apparent energies, voltage anomalies (voltage sag and surge) with 10ms resolution. **It will be possible to analyse the recorded data ONLY by transferring the data to a PC.**
- ✓ **Record simultaneously** (pressing the **START** key) values of Voltage and Current values coming from test leads and Clamp, using "**Typical Configurations**" with pre-programmed parameters inside the meter (see paragraph 10.2).**It will be possible to analyse the recorded data ONLY by transferring the data to a PC.**

It's fundamental the Instrument settings correspond to the Installation type under test and accessories in use. For this we recommend the user checks the instrument's settings before executing an ANALYSIS measurement.

Select the **ANALYSER** position on the rotary switch. By pressing the **MENU** key the following screen will be displayed:

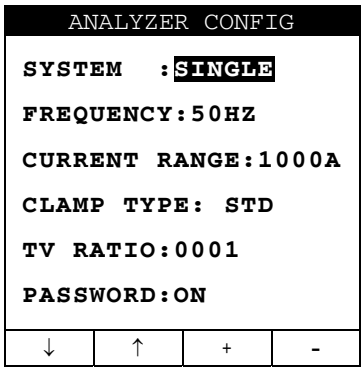


It's not possible to enter the **MENU** during a recording or a Real Time Energy measurement.

Generally to check instrument's settings you must check "ANALYZER CONFIG" and "RECORDER CONFIG" items.

8.1. BASIC SETTING: ANALYZER CONFIG

Place the rotary switch in the **ANALYSER** position, press the **MENU** key, using the **F1**/**F2** keys select the **ANALYZER CONFIG** item and press the **ENTER** Key.
The following screen will be displayed:



These settings can be confirmed by pressing the **ENTER** key or cancelled by pressing the **ESC** key.

8.1.1. Type of electrical system under test

The parameter SYSTEM is fixed to "SINGLE" value as GENIUS 5080E is able only to analyse a Single Phase system.

8.1.2. How to set the fundamental frequency

Position the cursor on the corresponding word by pressing the multifunction keys **F1** and **F2** and select the network frequency between the possible values **50Hz** and **60Hz** by pressing the multifunction keys **F3** and **F4**. This parameter is important ONLY if the input voltage is not sufficient to recognise the value of the frequency (for example, only the clamps for the current measurement are connected). In this case the instrument generates an internal synchronism equal to the value of the set frequency.

8.1.3. How to set the current range

The value of this parameter **must always be equal to the full scale of the current clamp** used to take the measurement. If a multi-scale clamp is used, the value of this parameter must be equal to the scale selected on the clamp.
Set the desired value by pressing the multifunction keys **F3** and **F4**.

8.1.4. Clamp Type

The value of this parameter shows that only Standard clamps (**STD)** or Current Transformers are available for this instrument. This parameter cannot be modified by the user.

8.1.5. How to set the value of the transformer voltage ratio (TV RATIO)

The instrument can also be interfaced with step-down transformers in the equipment under test. It can display the value of the voltages present on the primary winding of these transformers. To do this it will be necessary to set the value of the transformers' windings ratio from 2:1 to 3000:1. The default is set at 1:1 for measurements of none transformer systems. Select "TV RATIO" in the ANALYZER CONFIG menu. Set the desired value by pressing the multifunction keys **F3** and **F4**.

8.1.6. How to enable/disable the password

The instrument is provided with a protective routine to avoid the risk of being disturbed or interrupted during a recording or an energy measurement. Once a recording or a direct energy measurement has been started (with the option “PASSWORD” enabled), after about 3 minutes from the last key pressure or switch rotation it won’t be possible to press **START/STOP** to stop the recording, “PASSWORD” will be displayed and it will be necessary to insert the password.
In order to insert the password (which is not changeable), press the multifunction keys in the following sequence (within 10 seconds):

F1, **F4**, **F3**, **F2**

If you wait more than about 10 seconds the display will return to the meter mode and the instrument will continue recording. If you insert a wrong password the message “Password error” will be displayed under “PASSWORD”. After a few seconds the display will return to meter mode and the instrument will continue recording. In order to enable/disable this option the correct password will have to be entered. The display will return to meter mode and **START/STOP** will have to be pressed again to stop the recording. You will then need to re-enter the “ANALYZER CONFIG” menu and scroll up or down to the item “PASSWORD: ON” using the multifunction keys **F1** and **F2.** Then turn the password off by pressing the multifunction keys **F3** and **F4**.

8.2. BASIC SETTING: RECORDER CONFIG

Place the rotary switch in the **ANALYSER** position, press the **MENU** key, using the **F1**/**F2** keys select the **RECORDER CONFIG** and press the **ENTER** Key.
This option allows you to check and eventually modify the recording parameters and the selected parameters (up to a maximum of 62+Frequency). If the number of selected values exceeds 63 the message "too many param" will be displayed. The RECORDER CONFIG mode is divided into 4 separate sub-screens:

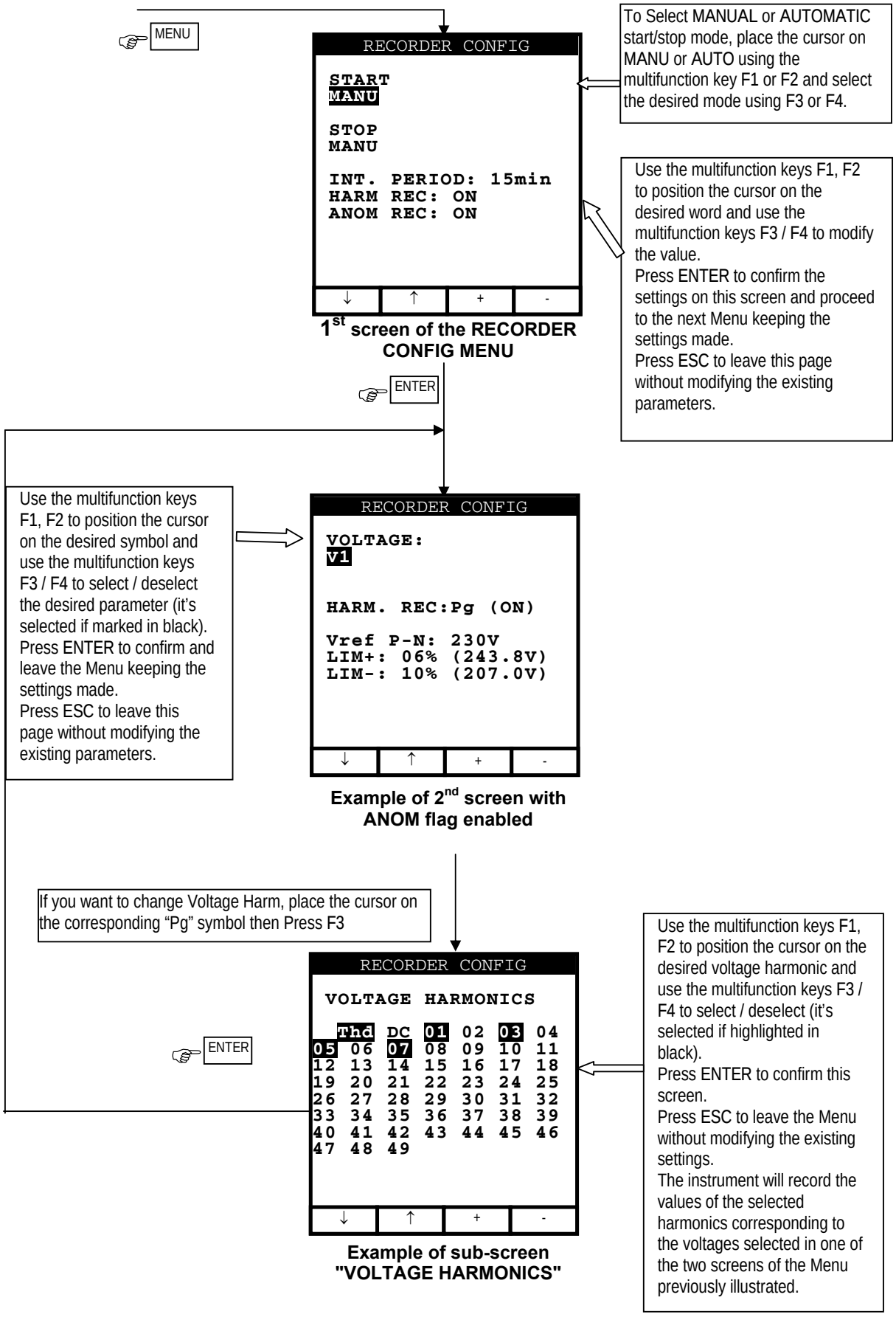
- ✓ 1st screen: This screen allows you to set the START/ STOP mode (AUTO or MANUAL), the START and STOP time if AUTO mode is selected, the Integration Period value, the Enabling/Disabling of Voltage Anomalies detection, the Enabling/Disabling of Harmonics detection. Press **ENTER** to confirm the settings and pass to the following screen.
  Press **ESC** to leave the Menu without modifying the existing parameters.

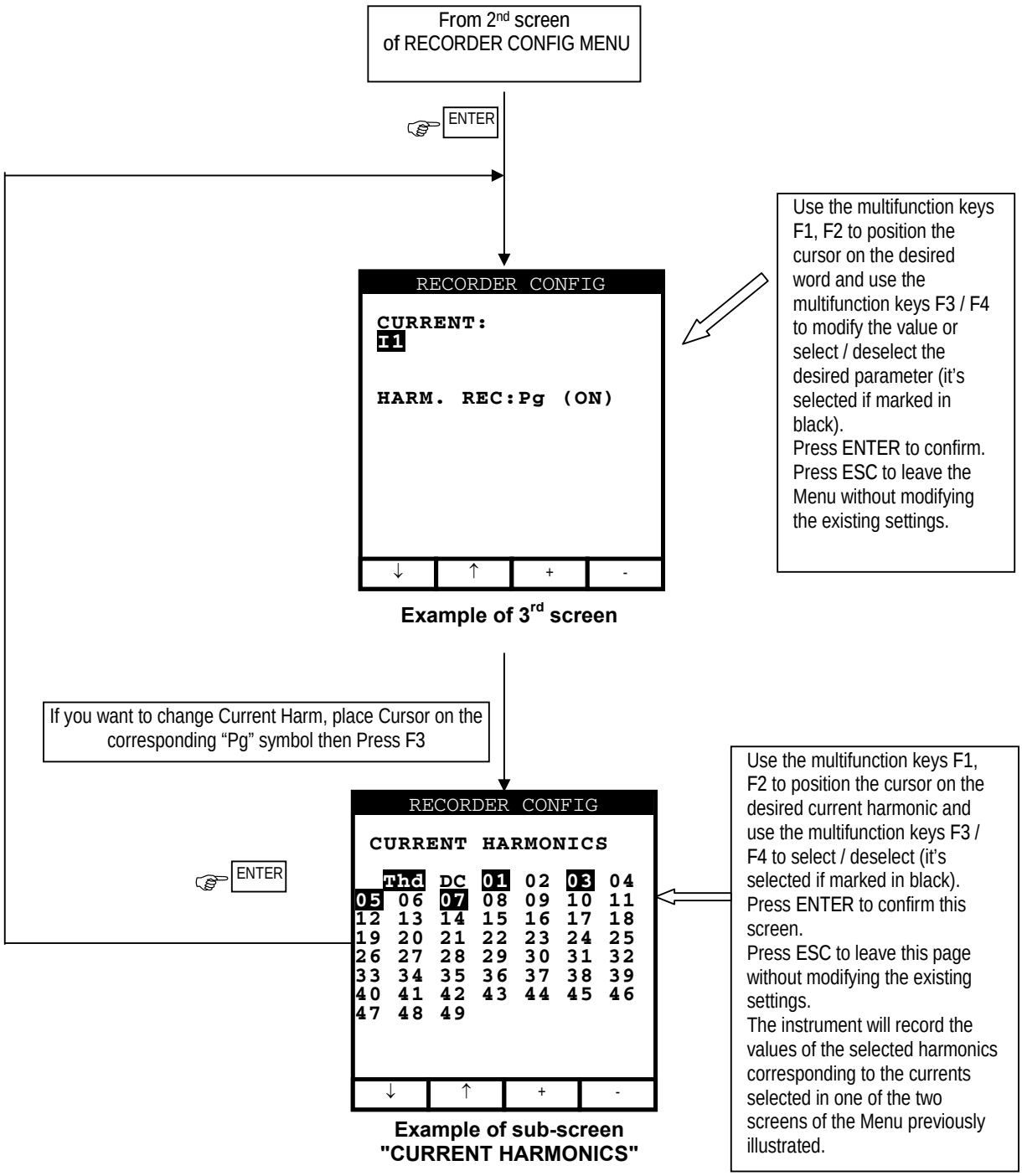
- ✓ 2nd screen: This screen is devoted to the settings relevant to the **VOLTAGE** recording.
  Press **ENTER** to confirm the settings and pass to the following page.
  Press **ESC** to leave this screen without modifying the existing parameters.
  From this page you can enter the sub-screen “Harmonics” which permits to select the voltage harmonics to be recorded.
  Press **ENTER** to confirm the settings and leave the “Menu Harmonics".
  Press **ESC** to leave the "Menu Harmonics" without modifying the existing parameters.

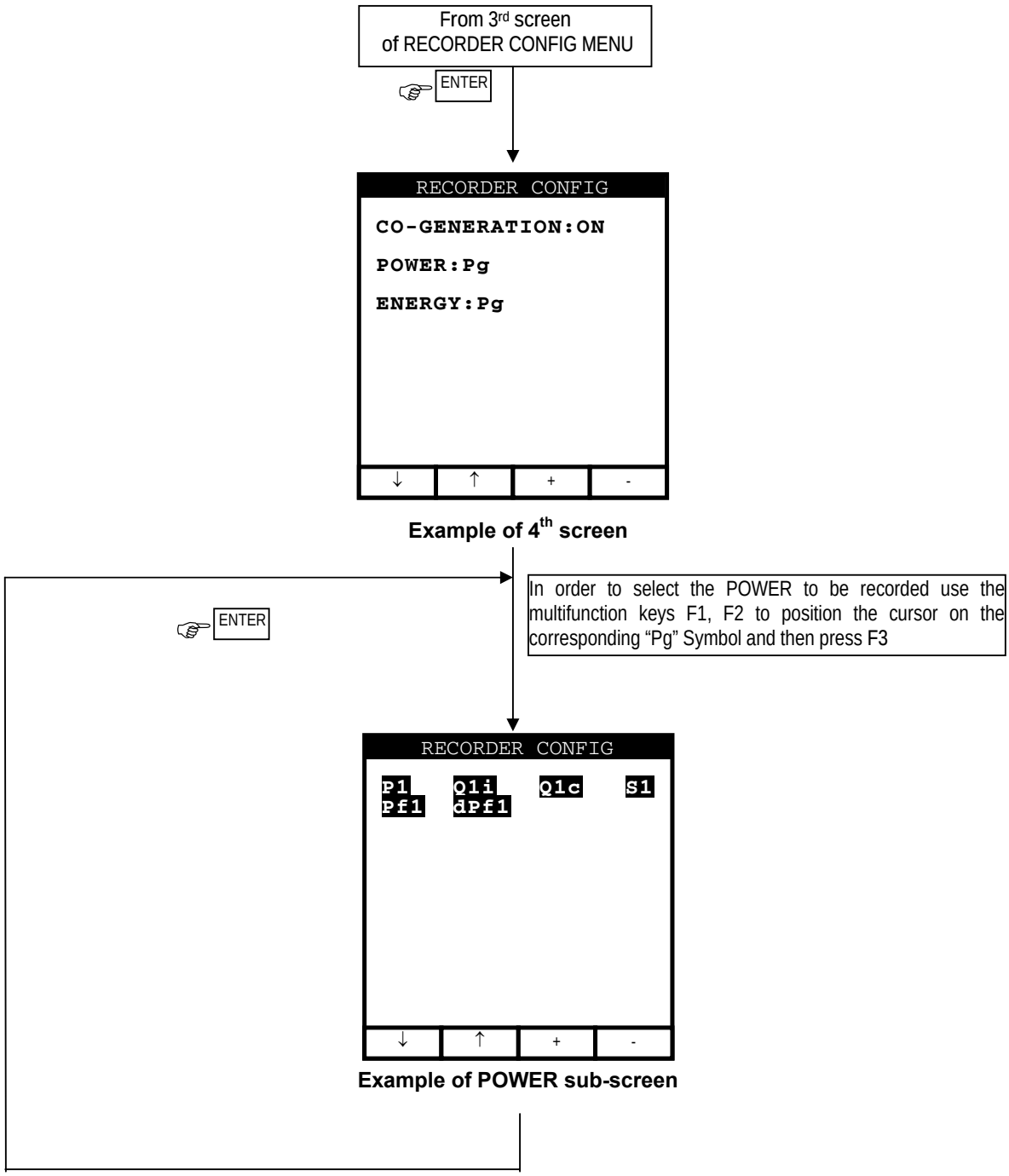
- ✓ 3rd screen: This screen is devoted to the settings relevant to the **CURRENT** recording.
  Press **ENTER** to confirm the settings and pass to the following screen.
  Press **ESC** to leave this screen without modifying the existing parameters.
  From this screen you can enter the sub-screen “Harmonics” which permits to select the current harmonics to be recorded.
  Press **ENTER** to confirm the settings and leave the “Menu Harmonics".
  Press **ESC** to leave the "Menu Harmonics" without modifying the existing parameters.

- ✓ 4th screen: Menu composed of two sub-screens devoted to the selection of the **POWERS and ENERGIES** to be recorded. From this screen you can enter the sub-screen “POWER” and “ENERGY” which permits the user to select the parameters to be recorded.
  Selecting the active powers for the recording, the corresponding active energies will be automatically selected.
  Selecting the reactive powers for the recording, the corresponding reactive energies will be selected.
  Press **ENTER** to leave this screen confirming the modifications made.
  Press **ESC** to leave the "Menu" without modifying the existing parameters.

The various screens of the "**RECORDER CONFIG**" can be schematised as follows:

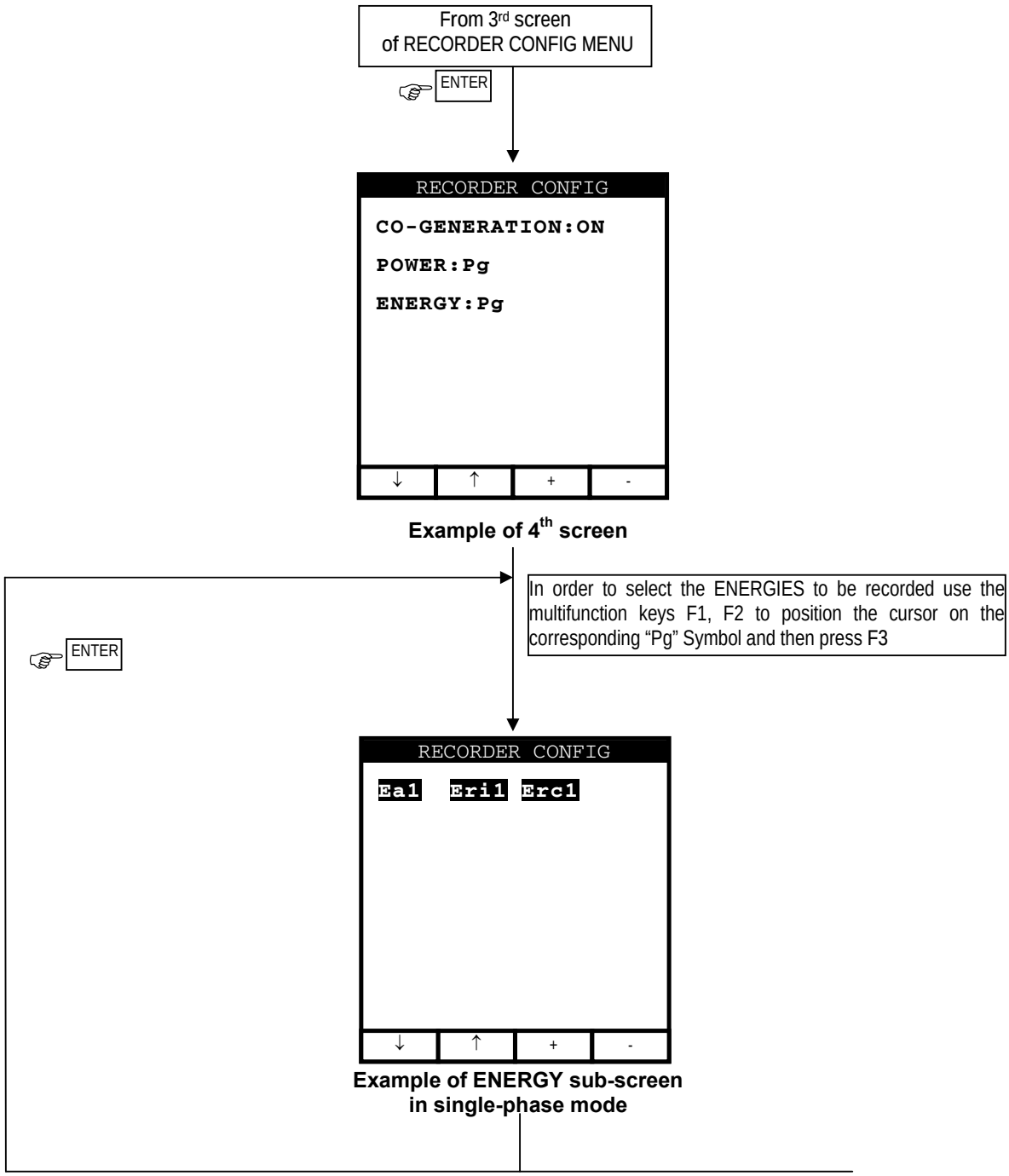

MENU
RECORDER CONFIG
START
MANU
STOP
MANU
INT. PERIOD: 15min
HARM REC: ON
ANOM REC: ON
↓
↑
+
-
To Select MANUAL or AUTOMATIC start/stop mode, place the cursor on MANU or AUTO using the multifunction key F1 or F2 and select the desired mode using F3 or F4.
Use the multifunction keys F1, F2 to position the cursor on the desired word and use the multifunction keys F3 / F4 to modify the value.
Press ENTER to confirm the settings on this screen and proceed to the next Menu keeping the settings made.
Press ESC to leave this page without modifying the existing parameters.
1st screen of the RECORDER CONFIG MENU
ENTER
Use the multifunction keys F1, F2 to position the cursor on the desired symbol and use the multifunction keys F3 / F4 to select / deselect the desired parameter (it's selected if marked in black).
Press ENTER to confirm and leave the Menu keeping the settings made.
Press ESC to leave this page without modifying the existing parameters.
RECORDER CONFIG
VOLTAGE:
V1
HARM. REC:Pg (ON)
Vref P-N: 230V
LIM+: 06% (243.8V)
LIM-: 10% (207.0V)
↓
↑
+
-
Example of 2nd screen with ANOM flag enabled
If you want to change Voltage Harm, place the cursor on the corresponding "Pg" symbol then Press F3
ENTER
RECORDER CONFIG
VOLTAGE HARMONICS
Thd DC 01 02 03 04
05 06 07 08 09 10 11
12 13 14 15 16 17 18
19 20 21 22 23 24 25
26 27 28 29 30 31 32
33 34 35 36 37 38 39
40 41 42 43 44 45 46
47 48 49
↓
↑
+
-
Example of sub-screen "VOLTAGE HARMONICS"
Use the multifunction keys F1, F2 to position the cursor on the desired voltage harmonic and use the multifunction keys F3 / F4 to select / deselect (it's selected if highlighted in black).
Press ENTER to confirm this screen.
Press ESC to leave the Menu without modifying the existing settings.
The instrument will record the values of the selected harmonics corresponding to the voltages selected in one of the two screens of the Menu previously illustrated.


From 2nd screen
of RECORDER CONFIG MENU
ENTER
RECORDER CONFIG
CURRENT:
I1
HARM. REC:Pg (ON)
↓
↑
+
-
Use the multifunction keys F1, F2 to position the cursor on the desired word and use the multifunction keys F3 / F4 to modify the value or select / deselect the desired parameter (it's selected if marked in black).
Press ENTER to confirm.
Press ESC to leave the Menu without modifying the existing settings.
Example of 3rd screen
If you want to change Current Harm, place Cursor on the corresponding "Pg" symbol then Press F3
ENTER
RECORDER CONFIG
CURRENT HARMONICS
Thd DC 01 02 03 04
05 06 07 08 09 10 11
12 13 14 15 16 17 18
19 20 21 22 23 24 25
26 27 28 29 30 31 32
33 34 35 36 37 38 39
40 41 42 43 44 45 46
47 48 49
↓
↑
+
-
Use the multifunction keys F1, F2 to position the cursor on the desired current harmonic and use the multifunction keys F3 / F4 to select / deselect (it's selected if marked in black).
Press ENTER to confirm this screen.
Press ESC to leave this page without modifying the existing settings.
The instrument will record the values of the selected harmonics corresponding to the currents selected in one of the two screens of the Menu previously illustrated.
Example of sub-screen
"CURRENT HARMONICS"



CAUTION

- Selecting the active power for the recording, the corresponding active energy will be automatically selected.
- Selecting the reactive powers for the recording, the corresponding reactive energies will be selected.



CAUTION

- Selecting/deselecting the active energy for the recording, the corresponding active power will be automatically selected/deselected.
- Selecting/deselecting the reactive energies for the recording, the corresponding reactive powers will be selected/deselected.

Symbols	Description	Advised settings
START:MAN	The recording of all the selected parameters will start at 00 seconds after pressing **START/STOP** (see chapter REF _Ref6712586 \r \h 10.1).	☺
STOP:MAN	The recording of all the selected parameters will be interrupted manually by pressing **START/STOP** (see chapter 10.1).	☺
START:AUTO STOP:AUTO	The recording of all the selected values will be started / interrupted at the set dates and times. In order to start the recording the user will have to press START/STOP to set the instrument in Stand-by mode until the start date and time previously set (see chapter REF _Ref6712622 \r \h 10.1).	
INT. PERIOD	The value of this parameter determines how many seconds will elapse before the values of **all the selected parameters** will be memorised (see chapter 16.13.1). Available choices: 5sec,10sec,30sec,1min,2min,5min,10min,15min,30min,60min.	**15min** ☺
HARM REC.	**ON** = the instrument will record the values of the selected **voltage and current harmonics**.	☺
	OFF = the instrument **will not record** any voltage or current harmonic selected	
ANOM REC.	**ON** = the Instrument will record Voltage Anomalies (voltage Sag and Surge) (see paragraph 16.10)	☺
	OFF = the instrument **will not record** any voltage Sag and Surge	
V1	Voltage RMS value	☺ **V1**
THD, DC, 01...49	Voltage Total Harmonic Distortion, DC Component, 01..49 Harmonics respectively.	☺ **THD,01,03,05,07**
Vref (Only if ANOM. REC flag has been set ON)	RMS reference value for Voltage used in Voltage Anomalies detection (Voltage Sag and Surge). The Reference is: a) Voltage Phase to Neutral for Single Phase and 4 wire three phase system. b) Voltage Phase to Phase for 3 wire three phase system.	☺ Single phase: **230V** 3 Phase system: 3 wires: **400V** 4 wires **230V**
LIM+, LIM- (Only if ANOM. REC flag has been set ON)	High and Low Voltage Percent threshold used in Voltage Anomalies detection (Voltage Sag and Surge). These parameters can be adjusted in range 3% ÷ 30% (step 1%). Example: Three Phase System 4 wire. Vref = 230, LIM+= 6%, LIM-=10% => High Lim = 243.8V, Low Lim = 207.0V The Instrument will detect a voltage Anomaly if the RMS Voltage Values (calculated every 10ms) are beyond the above calculated thresholds (see paragraph 16.10.	☺ **+6% / -10%**
I1	Current RMS value.	☺ **I1**
THD, DC, 01..49	Current Total Harmonic Distortion, DC Component, 01..49 Harmonics respectively	☺ **THD,01,03,05,07**

CO-GENERATION	ON = the instrument is able to face situations of CO-GENERATION of electrical equipment (that is, the equipment under test is able to generate energy besides absorbing it). Accordingly, the instrument will record the powers and energies both absorbed and generated (see paragraph 16.12.1). **If this flag is enabled the maximum number of parameters which can be selected decrease to 38.**	
	OFF = the instrument will record ONLY the powers and energies absorbed.	☺
P1	Active Power	☺ P1
Q1i	Inductive Reactive Power	☺ Q1i Q1c
Q1c	Capacitive Reactive Power	
S1	Apparent Power	☺ S1
Pf1	Power factor	☺ Pf1 dPf1
DPft1	cosφ	
Ea1	Active energy	☺ Ea1
Eri1	Inductive reactive energy	☺ Eri1 Erc1
Erc1	Capacitive reactive energy	

The value of the network frequency is automatically selected if the voltage is selected.

The symbols "**i**" and "**c**" stand for reactive powers (Q), power factors (Pf) and cosφ (dpf) inductive and capacitive respectively.

Selecting a power factor (Pf) or a cosφ (dPf) for recording automatically their inductive value and their capacitive value will be recorded separately.

For eventual messages displayed see Appendix 1 – MESSAGES DISPLAYED.

8.3. ANALYSER FUNCTIONS

F3
F4

☞ For a simple usage, the main working mode of the ANALYSER mode can be selected by means of **F3** and **F4**.

☞ "**VOLTAGE**" function: to be used to display **voltage and corresponding harmonics** (see paragraph 8.4)

☞ "**CURRENT**" function: to be used to display **current and corresponding harmonics** (see paragraph 8.5)

☞ "**POWER**" function: it permits to display **all the parameters measurable by the instrument**: voltage, current, active, reactive and apparent power, power factor, cosφ and energy (see paragraph 8.6)

☞ "**ENERGY**" function: to be used to display **active, reactive and apparent power, power factor, cosφ and energy** (see paragraph 8.7)

More practically, we may schematise the right procedure of use for the **ANALYSER** function as follows:

1. Check and eventually modify the "ANALYZER CONFIG" settings of the instrument
2. Using **F3** and **F4**, select the type of measurement to be taken
3. Connect the instrument to the electrical system to be tested
4. Evaluate the values of the parameters under test
5. If you want to record:
   a) Decide what to record
   b) Press **MENU** and check if the "RECORDER CONFIG" settings meet your requirements.
   c) Consider Typical Configuration recording (see paragraph 10.2).
6. Connect the External Power Supply MAR#### (optional)
7. Start the recording by pressing START/STOP.

8.4. "VOLTAGE" FUNCTION

✓ This function permits you to display in real time the RMS value of AC/DC voltage, the peak, the Thd value (see paragraph REF _Ref530398168 \r \h 16.11), the waveform and the harmonic spectrum of the voltage.

8.4.1. Symbols

The VOLTAGE position has three working modes:

✓ METER
✓ WAVE
✓ HARM

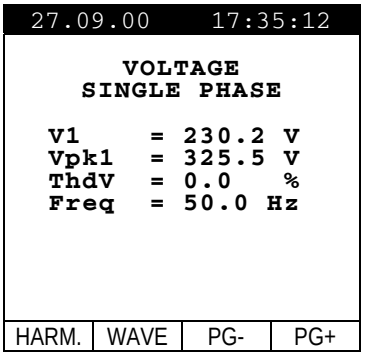
These modes will be described in detail in the next paragraphs.
The symbols used are described below:

Symbol	Description
V1	Voltage RMS value
Vpk1	Peak value of the voltage
h01 - h49	Harmonic 01 - Harmonic 49.
ThdV	Factor of total harmonic distortion of the voltage (see paragraph 16.11).
freq	Network frequency

Tab. 1: Symbols used in the position **VOLTAGE**

8.4.2. "METER" mode

In this mode the instrument shows the below screen according to the settings made as per paragraph 8.1.



Example of screen

The symbols used are described in Tab.1

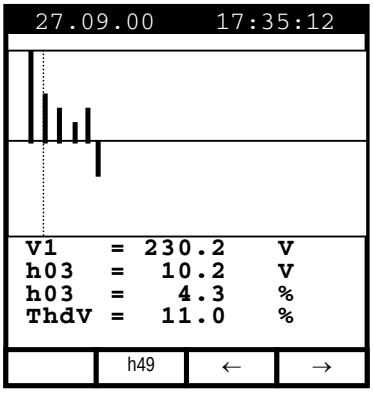
For eventual messages displayed see Appendix 1 – MESSAGES DISPLAYED.

Following keys are enabled:

- **F1**: to pass to "HARMONIC" mode (see paragraph 8.4.3).
- **F2**: to pass to "WAVE" mode (see paragraph 8.4.4).
- **F3/F4**: to pass to previous/next function respectively.
- **SAVE**: to save in the instrument memory a record of “Smp” type (see paragraph 9.2) containing the instantaneous values of voltage and current present on the instrument inputs. This function is disabled during a recording.
- **ENTER/HOLD**: to enable/disable the HOLD function (updating interruption) of the displayed data. All the previous functions remain however available. When the HOLD function is enabled, the word HOLD is displayed. When this function is enabled it’s not possible to record or take an energy measurement. This function is disabled during a recording or an energy measurement.
- **MENU**: to enter in the **MENU** mode and change the instrument settings (see paragraph 8.1 and 8.2). It’s not possible to enter the configuration MENU during a recording or an energy measurement.
- **START/STOP**: to record the **selected parameters** according to the instrument’s settings (see chapter 10).

8.4.3. "HARM" mode

Selecting the HARM mode the screen below will be displayed according to the settings made as per paragraph 8.1. The screen shows the harmonics (see paragraph 16.11) of the voltage.



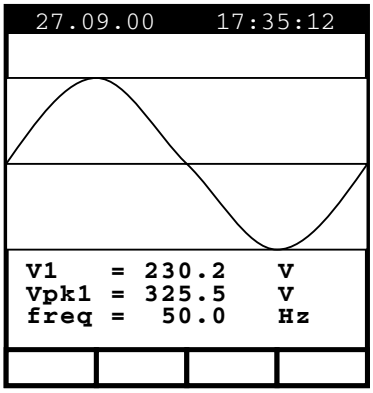
Example of screen

The symbols used are described in Tab. 1. For eventual messages displayed see Appendix 1 – MESSAGES DISPLAYED. The displayed histograms represent the harmonic content of the voltage under test. The value of the first harmonic h01 (fundamental at 50Hz) is not represented in scale along with the other harmonics in order to maximize the display of the latter. In both cases voltage and current are connected to the instrument inputs, eventual negative values of the harmonics (therefore represented under the horizontal axis), indicate that such voltage harmonics are “generated” by the load. Following keys are enabled:

- ☞ **F3**, **F4**: to move the cursor of the selected harmonic leftwards and rightwards respectively. At the same time the values relevant to the order no. of the selected harmonic and to the corresponding absolute and relative values (calculated on the basis of the fundamental) are updated.
- ☞ **F2**: to display the page of the harmonics h01 ÷ h24 (symbol **h24**) or that of the harmonics h25 ÷ h49 (symbol **h49**).
- ☞ **ESC**: to return back to METER mode (see paragraph 8.4.2).
- ☞ **SAVE**: to save in the instrument memory a record of “Smp” type (see paragraph 9.2) and the instantaneous values of voltage and current present on the instrument inputs. This function is disabled during a recording.
- ☞ **ENTER/HOLD**: to enable/disable the HOLD function (updating interruption) of the displayed data. All the previous functions remain however available. When the HOLD function is enabled, the word HOLD is displayed. When this function is enabled it’s not possible to record or take an energy measurement. This function is disabled during a recording or an energy measurement.
- ☞ **MENU**: to enter in the **MENU** mode and change the instrument settings (see paragraph 8.1 and 8.2). It’s not possible to enter the configuration MENU during a recording or an energy measurement.
- ☞ **START/STOP**: to record **selected parameters** according to the instrument’s settings (see chapter 10).

8.4.4. "WAVE" mode

Selecting the WAVE mode the screen below will be displayed according to the settings made as per paragraph 8.1. The screen shows the waveform of the voltage.



Example of screen

The symbols used are described in Tab. 1. For eventual messages displayed see Appendix 1 – MESSAGES DISPLAYED. Following keys are enabled:

- ☞ **ESC**: to return back to METER mode (see paragraph 8.4.2).
- ☞ **SAVE**: to save in the instrument memory a record of "Smp" type (see paragraph 9.2) containing the instantaneous values of voltage and current present on the instrument inputs. This function is disabled during a recording.
- ☞ **ENTER/HOLD**: to enable/disable the HOLD function (updating interruption) of the displayed data. All the previous functions remain however available. When the HOLD function is enabled, the word HOLD is displayed. When this function is enabled it's not possible to record or take an energy measurement. This function is disabled during a recording or an energy measurement.
- ☞ **MENU**: to enter in the **MENU** mode and change the instrument settings (see paragraph 8.1 and 8.2). It's not possible to enter the configuration MENU during a recording or an energy measurement.
- ☞ **START/STOP**: to record **selected parameters** according to the instrument's settings (see chapter 10).

8.5. "CURRENT" FUNCTION

This function permits to display in real time the RMS value of AC/DC current, the peak, the Thdl value (see paragraph 16.11), the waveform and the harmonic spectrum of the current.

8.5.1. Symbols

The CURRENT position has three working modes:

- ✓ METER
- ✓ WAVE
- ✓ HARM

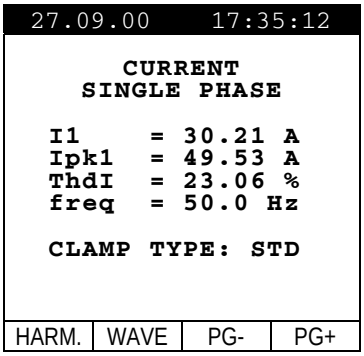
These modes will be described in detail in the next paragraphs.
The symbols used are described below:

Symbol	Description
I1	Current RMS value
Ipk1	Peak value of the current
h01 - h49	Harmonic 01 - harmonic 49.
ThdI	Total harmonic distortion factor of the current (see paragraph 16.11).
freq	Network frequency

Tab. 2: Symbols used in the position **CURRENT**

8.5.2. “METER" mode

In this mode the instrument shows the below screen according to the settings made as per paragraph 8.1.



Example of screen

The symbols used are described in Tab. 2.

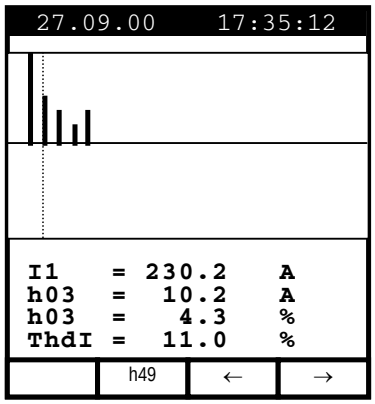
For eventual messages displayed see Appendix 1 – MESSAGES DISPLAYED.

Following keys are enabled:

- **F1**: to pass to "HARMONIC" mode (see paragraph 8.5.3).
- **F2**: to pass to "WAVE" mode (see paragraph 8.5.4).
- **F3/F4**: to pass to previous/next function respectively.
- **SAVE**: to save in the instrument memory a record of “Smp” type (see paragraph 9.2) containing the instantaneous values of voltage and current present on the instrument inputs. This function is disabled during a recording.
- **ENTER/HOLD**: to enable/disable the HOLD function (updating interruption) of the displayed data. All the previous functions remain however available. When the HOLD function is enabled, the word HOLD is displayed. When this function is enabled it’s not possible to record or take an energy measurement. This function is disabled during a recording or an energy measurement.
- **MENU**: to enter in the **MENU** mode and change the instrument settings (see paragraph 8.1 and 8.2). It’s not possible to enter the configuration MENU during a recording or an energy measurement.
- **START/STOP**: to record **selected parameters** according to the instrument’s settings (see chapter 10).

8.5.3. "HARM" mode

Selecting the HARM mode the screen below will be displayed according to the settings made as per paragraph 8.1. The screen shows the harmonics (see paragraph 16.11) of the current.



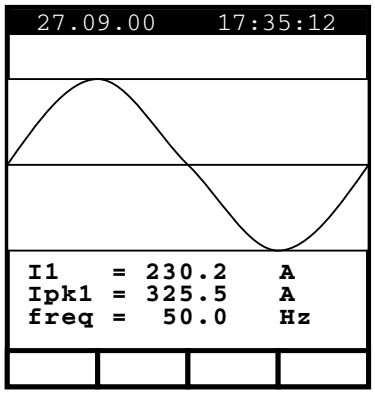
Example of screen

The symbols used are described in Tab. 2. For eventual messages displayed see Appendix 1 – MESSAGES DISPLAYED. The displayed histograms represent the harmonic content of the current under test. The value of the first harmonic h01 (primary at 50Hz) is not represented in scale along with the other harmonics in order to maximise the display of the latter. In case both voltage and current are connected to the instrument inputs, eventual negative values (therefore represented under the horizontal axis), indicate that such current harmonics are "generated" by the load. Following keys are enabled:

- ☞ **F3**, **F4**: to move the cursor of the selected harmonic left and right respectively. At the same time the values relevant to the order no. of the selected harmonic and to the corresponding absolute and relative values (calculated on the basis of the fundamental) are updated.
- ☞ **F2**: to display the page of the harmonics h01 - h24 (**h24** symbol) or that of the harmonics h25 - h49 (**h49** symbol).
- ☞ **ESC**: to return back to METER mode (see paragraph 8.5.2)
- ☞ **SAVE**: to store in the instrument memory a record of "Smp" type (see paragraph 9.2) and the instantaneous values of voltage and current present on the instrument inputs. This function is disabled during a recording.
- ☞ **ENTER/HOLD**: to enable/disable the HOLD function (updating interruption) of the displayed data. All the previous functions remain however available. When the HOLD function is enabled, the word HOLD is displayed. When this function is enabled it's not possible to record or take an energy measurement. This function is disabled during a recording or an energy measurement.
- ☞ **MENU**: to enter in the **MENU** mode and change the instrument settings (see paragraph 8.1 and 8.2). It's not possible to enter the configuration MENU during a recording or an energy measurement.
- ☞ **START/STOP**: to record **selected parameters** according to the instrument's settings (see chapter 10).

8.5.4. "WAVE" mode

Selecting the WAVE mode the screen below will be displayed according to the settings made as per paragraph 8.1. The screen shows the waveform of the current.



Example of screen

The symbols used are described in Tab. 2.

For eventual messages displayed see Appendix 1 – MESSAGES DISPLAYED.

Following keys are enabled:

- **ESC**: to return back to METER mode (see paragraph 8.5.2).
- **SAVE**: to save in the instrument memory a record of “Smp” type (see paragraph 9.2) containing the instantaneous values of voltage and current present on the instrument inputs. This function is disabled during a recording.
- **ENTER/HOLD**: to enable/disable the HOLD function (updating interruption) of the displayed data. All the previous functions remain however available. When the HOLD function is enabled, the word HOLD is displayed. When this function is enabled it’s not possible to record or take an energy measurement. This function is disabled during a recording or an energy measurement.
- **MENU**: to enter in the **MENU** mode and change the instrument settings (see paragraph 8.1 and 8.2). It’s not possible to enter the configuration MENU during a recording or an energy measurement.
- **START/STOP**: to record **selected parameters** according to the instrument’s settings (see chapter 10).

8.6. "POWER" FUNCTION

This function permits to display in real time the RMS value of AC/DC voltage, the peak and ThdV value and the waveform of the voltage, the RMS value of AC/DC currents, the peak, ThdI value and the waveform of the current. Furthermore, the instrument calculates and displays the value of the active, reactive and apparent power and the value of the power factors and cosφ.

8.6.1. Symbols

The position POWER has two working modes:

- ✓ METER
- ✓ WAVE

For voltage and current harmonics see paragraphs 8.4.3 and 8.5.3 respectively.

These modes will be described in detail in the next paragraphs.
The symbols used are described below:

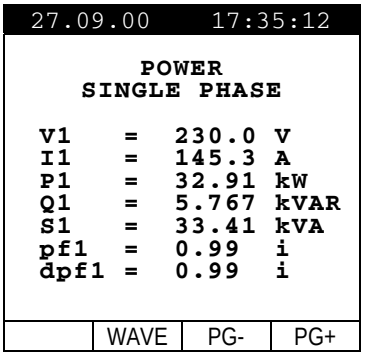
Symbol	Description
V1	Voltage RMS value
freq	Network frequency
I1	Current RMS value
P1	Active power
Q1	Reactive power
S1	Apparent power
Pf1	Power factor
dpf1	cosφ

Tab. 3: Symbols used in the position **POWER**

The symbols "**i**" and "**c**" stand for reactive powers (Q), power factors (Pf) and cosφ (dpf) respectively inductive and capacitive.

8.6.2. "METER" mode

In this mode the instrument shows the below screen according to the settings made as per paragraph 8.1.



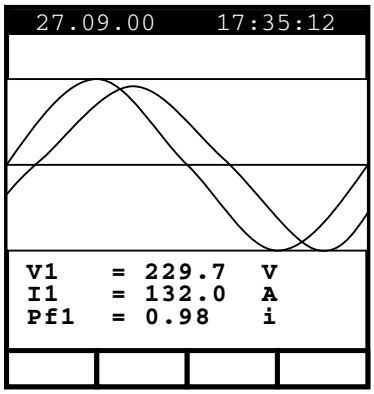
Example of screen

The symbols used are described in Tab. 3.
For eventual messages displayed see Appendix 1 – MESSAGES DISPLAYED
Following keys are enabled:

- ☞ **F2**: to pass to "WAVE" mode (see paragraph 8.6.3).
- ☞ **F3/F4**: to pass to previous/next function respectively.
- ☞ **SAVE**: to save in the instrument memory a record of “Smp” type (see paragraph 9.2) and the instantaneous values of voltage and current present on the instrument inputs. This function is disabled during a recording.
- ☞ **ENTER/HOLD**: to enable/disable the HOLD function (updating interruption) of the displayed data. All the previous functions remain however available. When the HOLD function is enabled, the word HOLD is displayed. When this function is enabled it’s not possible to record or take an energy measurement. This function is disabled during a recording or an energy measurement.
- ☞ **MENU**: to enter in the **MENU** mode and change the instrument settings (see paragraph 8.1 and 8.2). It’s not possible to enter the configuration MENU during a recording or an energy measurement.
- ☞ **START/STOP**: to record **selected parameters** according to the instrument’s settings (see chapter 10).

8.6.3. "WAVE" mode

Selecting the WAVE mode the screen below will be displayed according to the settings made as per paragraph 8.1. The screen shows the waveform of the current and the voltage.



Example of screen

The symbols used are described in Tab. 3.

For eventual messages displayed see appendix 1 – MESSAGES DISPLAYED.

Following keys are enabled:

- ☞ **ESC**: to return back to METER mode (see paragraph 8.6.2).
- ☞ **SAVE**: to save in the instrument memory a record of “Smp” type (see paragraph 9.2) containing the instantaneous values of voltage and current present on the instrument inputs. This function is disabled during a recording.
- ☞ **ENTER/HOLD**: to enable/disable the HOLD function (updating interruption) of the displayed data. All the previous functions remain however available. When the HOLD function is enabled, the word HOLD is displayed. When this function is enabled it’s not possible to record or take an energy measurement. This function is disabled during a recording or an energy measurement.
- ☞ **MENU**: to enter in the **MENU** mode and change the instrument settings (see paragraph 8.1 and 8.2). It’s not possible to enter the configuration MENU during a recording or an energy measurement.
- ☞ **START/STOP**: to record **selected parameters** according to the instrument’s settings (see chapter 10).

8.7. "ENERGY" FUNCTION

This function permits to display the values of the active powers, capacitive and inductive reactive powers, power factor and cosφ. Furthermore, the instrument is able to measure directly (see 8.7.2) the values of the energies and the values of the capacitive and inductive reactive energies.

8.7.1. Symbols

The position ENERGY has only one working mode:

- ✓ METER

This mode will be described in detail in the next paragraphs.
The symbols used are described below:

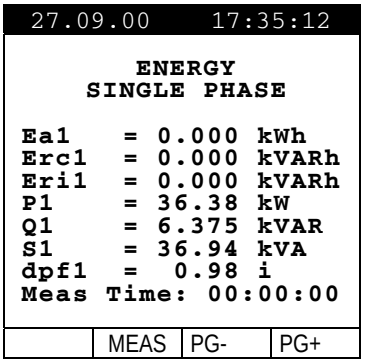
Symbol	Description
P1	Active power
Q1	Reactive power
S1	Apparent power
pf1	Power factor
dpf1	cosφ
Ea1	Active energy
Eri1	Inductive reactive Energy
Erc1	Capacitive reactive Energy

Tab. 4: Symbols used in the position **ENERGY**

The symbols "**i**" and "**c**" stand for reactive powers (Q) and energies (Er) inductive and capacitive respectively.

8.7.2. "METER" mode

In this mode the instrument shows the below screens according to the settings made as per paragraph 8.1.



Example of screen

The symbols used are described in Tab. 4.
For eventual messages displayed see Appendix 1 – MESSAGES DISPLAYED.
Following keys are enabled:

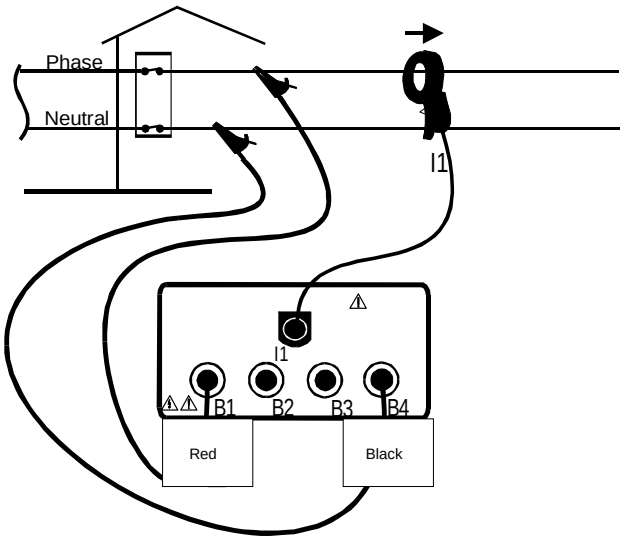
- ☞ **F2**: to start / stop immediately a **direct energy measurement**. The energy counters will start increasing proportionally to the active power absorbed by the load.
  The results obtained cannot be memorised.
  If the active power is negative the counters will not increase.
- ☞ **F3/F4**: to pass to previous/next function respectively.
- ☞ **SAVE**: to save in the instrument memory a record of “Smp” type (see paragraph 9.2) containing the instantaneous values of voltage and current present on the instrument inputs. This function is disabled during a recording.
- ☞ **ENTER/HOLD**: to enable/disable the HOLD function (updating interruption) of the displayed data. All the previous functions remain however available. When the HOLD function is enabled, the word HOLD is displayed. When this function is enabled it’s not possible to record or take an energy measurement. This function is disabled during a recording or an energy measurement.
- ☞ **MENU**: to enter in the **MENU** mode and change the instrument settings (see paragraph 8.1 and 8.2). It’s not possible to enter the configuration MENU during a recording or an energy measurement.
- ☞ **START/STOP**: to record **selected parameters** according to the instrument’s settings (see chapter 10).

8.8. MEASURING PROCEDURES

8.8.1. Using the Instrument in a Single Phase System

CAUTION

The maximum voltage between B1 and B4 inputs is 600 V~ (CATII) / 350V~ phase – earth or 600V~ (CATIII) / 300 V~ phase to earth.
Do not measure voltages exceeding the limits prescribed by this manual. Should you exceed the voltage limits you could damage the instrument and/or its components or endanger your safety.



Instrument connection in a single-phase system

CAUTION

If possible, before connecting the instrument to the electrical equipment to be tested take the power supply off the electrical equipment.

1. Check, and if needed modify, the basic settings of the instrument (see paragraphs 8.1 and 8.2).
2. Select the working mode corresponding to the type of analysis desired. In case of doubts select the **POWER** working mode (see paragraph 8.6).
3. Connect the phase and neutral voltage wires respecting the connections shown in the picture.
4. If you want to measure current and power, connect the clamp meter to the phase conductor respecting the specifications shown on the clamp and the connections shown in the picture.
   In case of doubts select the **POWER** working mode and check if the active power P is positive. If it's negative, remove current transducer from the wire and reconnect it so the transducer label faces the opposite direction.
5. Apply voltage to the electrical equipment under test (if previously shut off for the instrument connection).
6. The values of the available electrical parameters will be displayed on the display of the instrument. For further details see the paragraph relevant to the position of the switch.
7. You can press **HOLD** to interrupt the updating in real time of the displayed values.
8. You can press **SAVE** to save the displayed values (see paragraph 9.2).
9. If you want to record:

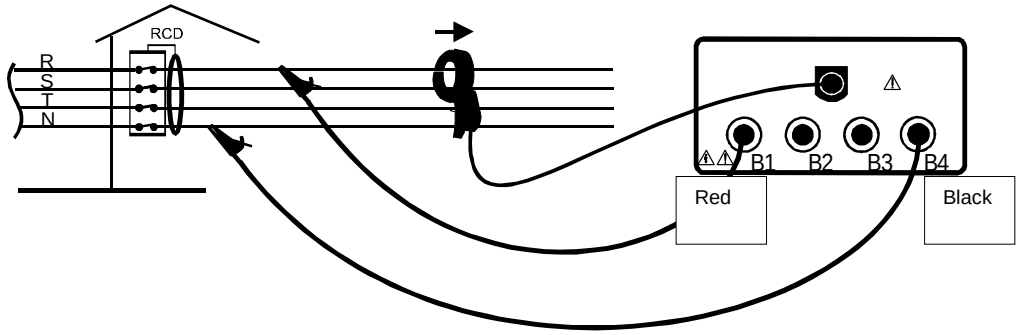
a) Check, and if needed modify, the values of the basic parameters (see paragraphs 8.1 and 8.2).
b) Check, and if needed modify, the recording parameters by pressing **MENU** (see the paragraph corresponding to the position of the rotary switch selected).
c) To start the recording press **START** (see chapter 6).

8.8.2. Using the Instrument in a Three Phase System

CAUTION

The maximum voltage between B1 and B4 inputs is 600 V~ (CATII) / 350V~ phase – earth or 600V~ (CATIII) / 300 V~ phase to earth.
Do not measure voltages exceeding the limits prescribed by this manual. Should you exceed the voltage limits you could damage the instrument and/or its components or endanger your safety.

The instrument is a single phase system. So you can analyse a three phase system repeating 3 times a single phase analysis described in previous paragraph.



Instrument connection in a three-phase system

The Three Phase power values are given by:

Total Active Power = Pt = P1 + P2 + P3

Total Reactive Power = Qt= Q1 + Q2 + Q3

Total Apparent Power = St = $\sqrt{(Pt^2 + Qt^2)}$

9. SAVING RESULTS

The **SAVE** button can be used to store the displayed results related to the rotary switch position:

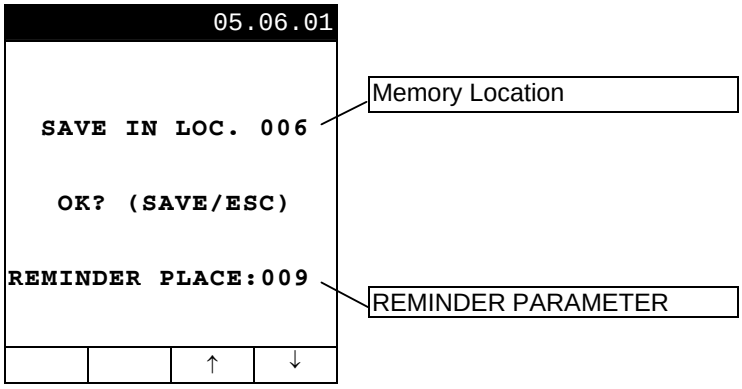
- ✓ SAFETY TEST and for AUX rotary switch position: pressing this key the instrument will store the displayed result generating a corresponding record in the SAFETY TEST MEMORY (see paragraph 11.1)
- ✓ ANALYSER rotary switch position: pressing this key the instrument will store the displayed result generating a "Smp" record in the ANALYZER MEMORY (see paragraph 11.2)

Please note that saving results is different from recording.

9.1. SAVING SAFETY TEST RESULTS

After a SAFETY TEST (function LOWΩ, MΩ, RCD, LOOP, Phase sequence, EARTH) or during a real time measurement in AUX position the user can press the SAVE button to store the displayed result.

☞ The REMINDER PLACE parameter is not related to the Measurement Order Number and can help to remind the user the place where the measurement was performed.



The following keys are available:

- ☞ **F3**, **F4**: to adjust the REMINDER PLACE.
- ☞ **SAVE**: to store the test result associating to the actual REMINDER PLACE
- ☞ **ESC**: to quit this mode without saving.

9.2. SAVING DISPLAYED VALUES OF ANALYSER FUNCTION

During a Real Time measurement (in ANALYSER function) if the user presses the SAVE button, a "Smp" record will be generated in the "ANALYZER MEMORY". This file contains the Voltage and Current values present at the instrument's input when the user pressed the SAVE key.
Downloading these values to a PC (using the management Software) the Power, Energy, Harmonics; etc values can be calculated and displayed as well.

10. RECORDINGS

10.1. START A RECORDING

The recording function is available for **ANALYSER** and **AUX** rotary switch position.
As you can read in the paragraphs 7.2.1 and 8.2, a recording can be started manually or automatically. Therefore, after setting all the parameters **and leaving the Menu**, the instrument will start to record:

- ✓ MANUALLY: the recording will start when the Instruments time reaches the “00” seconds value after pressing **START/STOP**.
- ✓ AUTOMATICALLY: **If the operator has pressed START/STOP** the instrument will remain in stand-by until the date and time previously set, then the recording will start. While **if the operator doesn’t press START/STOP the recording will never start.**

CAUTION

For recordings **we recommend to use the external power supply adapter** (optional code MAR####) even the instrument allows the operator to perform a recording using internal batteries.

If you press Start a recording without the external power supply adapter (optional code MAR####) the instrument will display a warning message “**No ext supply**”. Press **START** key again to run the recording or press **ESC** to quit.

If during a recording the external power supply adapter (optional code MAR####) is de-energised, the instrument will continue the recording using the internal battery power until the batteries are exhausted (the data stored until the definitive turning off won’t get lost). For this we recommend you **ALWAYS insert a new set of batteries before a long recording**.

The instrument uses sophisticated algorithms to prolong the battery life. Particularly:

- ✓ The instrument switches OFF the backlight automatically after 5 seconds.
- ✓ If the Battery level is too low the Backlight function will be disabled.
- ✓ If the instrument is just displaying in real time (and the external power supply is not connected), after about 5 minutes from the last key pressure or switch rotation the instrument turns off automatically ("AUTOPOWER OFF" function).
- ✓ If the instrument is recording or is measuring energy (and the external power supply is not connected), after about 5 minutes from the last key pressure or switch rotation the instrument starts a special procedure to save the batteries ("ECONOMY MODE"): the instrument keeps recording but the display is turned off.

Before starting a recording the operator should first evaluate the state of the equipment, decide what to record and set the instrument accordingly.

10.2. SETTING TYPICAL CONFIGURATIONS

In order to facilitate this task, the instrument is provided with the following two pre-set recording modes:

1. **Default Configuration:** this is comprehensive which should fit most cases**.**
2. **Typical Configuration**: it is possible to select recording with pre-setting parameters for the following situations:

EN50160	Setting parameters for Networks Quality in compliance with EN 50160 standard (see paragraph 16.11.2).
SURGES & DIPS	Setting parameters for Voltage Anomalies detection (surges, dips, break, etc.) (See paragraph 16.10).
HARMONICS	Setting parameters for Harmonics Analysis of Voltage and Current (see paragraph 16.11).
START-UP	Setting parameters for Start-Up motors and electrical devices.
POWER & ENERGY	Setting parameters for Power and Energy measures (see paragraph 16.12).

10.2.1. Default Configuration

The default configuration of instrument consists in the following parameters settings:

✓ ANALYZER CONFIG:

System:	SINGLE
Frequency:	50Hz
Current Range:	1000A
Clamp Type:	STD
TV Ratio:	1
Password:	enabled

✓ RECORDER CONFIG:

Start:	MANU (the recording is started 1 minute after pressing the START/STOP key)
Stop:	MANU
Integration period:	15min
Recording of harmonics:	ON
Recording of Voltage anomalies (voltage Sag and Surge) :	ON
Voltage Reference for Sag and Surge detection:	230V
Upper Limit for Sag and Surge detection:	6%
Lower Limit for Sag and Surge detection:	10%
Selected voltages:	V1
Selected voltage harmonics:	THD, 01, 03, 05, 07
Selected currents:	I1
Selected current harmonics:	THD, 01, 03, 05, 07
CO-GENERATION:	OFF
Powers, Pf and cosφ selected:	P1 Q1i Q1c S1 Pf1 dpf1
Energies:	Ea1 Eri1 Erc1

If the user changed the instrument's settings, the user can quickly resume the above configuration using the RESET option (see paragraph 5.4).

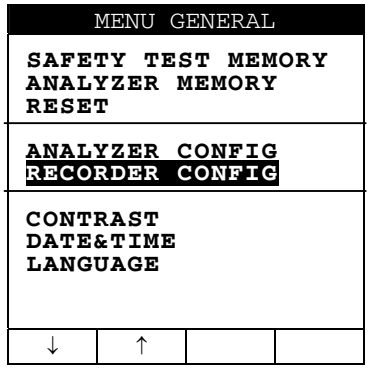
By pressing **START/STOP** the recording of the selected parameters is started according to the settings made in the MENU (see paragraphs 8.1 and 8.2). The rotary switch position doesn't affect the recording setting.

As the default value of the integration periods is set at 15 minutes the instrument will store data in the temporary memory for 15 minutes. Afterwards the instrument will elaborate the results saved in the temporary memory and will save the result of this elaboration (min, avg, and max values) in the definitive memory. Therefore, if an integration period of 15 minutes has been set, the recording will continue for about 15 minutes before producing a series of recorded values. If the recording is interrupted before the selected integration period has completely elapsed the data stored in the temporary memory will not be elaborated and the corresponding series of values won't be transferred to the definitive memory.

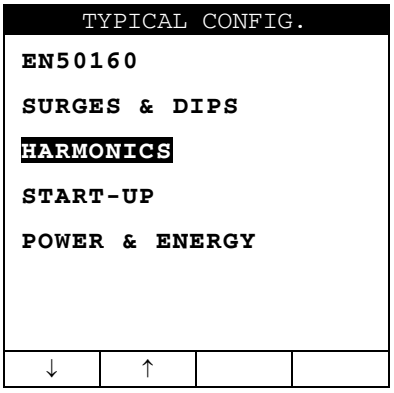
10.2.2. Typical Configurations

To activate the Typical Configurations, follow this procedure:

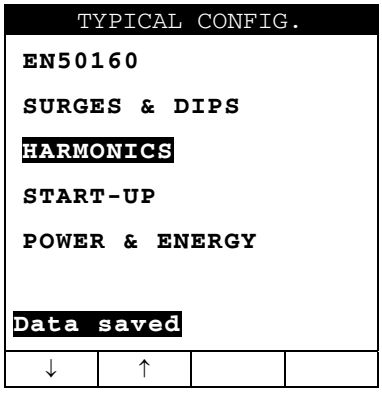
1. Turn the rotary switch to "**ANALYSER**".
2. Press **MENU** key followed by F1/F2 to navigate to the following screen:



3. Press **MENU** key again. The instrument displays a screen as shown below (picture on the left). This way it is possible to select the desired configuration with **F1** or **F2** key.



Configuration selection



Confirmation configuration selection

4. Press **ENTER** key. The instrument displays the message "**Data saved**" for a while to confirm the desired configuration (see above on the right). The instrument will return to the measure mode.

Below you can find the parameters for each of **5** Typical Configurations:

EN50160

✓ ANALYZER CONFIG:

System:	SINGLE
Frequency:	50Hz
Current Range:	not modified
Clamp Type:	STD
TV Ratio:	not modified
Password:	not modified

✓ RECORDER CONFIG:

Start:	MANU (the recording is started 1 minute after pressing the **START/STOP** key)
Stop:	MANU
Integration period:	10min
Recording of harmonics:	ON
Recording of Voltage anomalies (voltage Dips and Surge) :	ON
Voltage Reference for Dips and Surge detection:	230V
Upper Limit for Dips and Surge detection:	6%
Lower Limit for Dips and Surge detection:	10%
Selected voltages:	V1
Selected voltage harmonics:	THD, DC, 01, 02, 03, 04, … 25
CO-GENERATION:	OFF

SURGES & DIPS

✓ ANALYZER CONFIG:

System:	SINGLE
Frequency:	50Hz
Current Range:	not modified
Clamp Type:	STD
TV Ratio:	not modified
Password:	not modified

✓ RECORDER CONFIG:

Start:	MANU (the recording is started 1 minute after pressing the **START/STOP** key)
Stop:	MANU
Integration period:	1min
Recording of harmonics:	OFF
Recording of Voltage anomalies (voltage Dips and Surge) :	ON
Voltage Reference for Dips and Surge detection:	230V
Upper Limit for Dips and Surge detection:	6%
Lower Limit for Dips and Surge detection:	10%
Selected voltages:	V1
Selected current:	I1
CO-GENERATION:	OFF

HARMONICS

✓ ANALYZER CONFIG:

System:	SINGLE
Frequency:	50Hz

Current Range:	not modified
Clamp Type:	STD
TV Ratio:	not modified
Password:	not modified

✓ RECORDER CONFIG:

Start:	MANU (the recording is started 1 minute after pressing the **START/STOP** key)
Stop:	MANU
Integration period:	10min
Recording of harmonics:	ON
Recording of Voltage anomalies (voltage Dips and Surge) :	OFF
Selected voltages:	V1
Sel. Harmonics voltage :	THD,DC,01,03,05,07,09,11,13,15,17,19,21,23,25
Selected current:	I1
Sel. Harmonics current:	THD,DC,01,03,05,07,09,11,13,15,17,19,21,23,25
CO-GENERATION:	OFF

START-UP

✓ ANALYZER CONFIG:

System:	SINGLE
Frequency:	50Hz
Current Range:	not modified
Clamp Type:	STD
TV Ratio:	not modified
Password:	not modified

✓ RECORDER CONFIG:

Start:	MANU (the recording is started 1 minute after pressing the **START/STOP** key)
Stop:	MANU
Integration period:	5sec
Recording of harmonics:	ON
Recording of Voltage anomalies (voltage Dips and Surge) :	ON
Voltage Reference for Dips and Surge detection:	230V
Upper Limit for Dips and Surge detection:	6%
Lower Limit for Dips and Surge detection:	10%
Selected voltages:	V1
Selected voltage harmonics:	THD, 01, 03, 05, 07, 09, 11, 13, 15
Selected currents:	I1
Selected current harmonics:	THD, 01, 03, 05, 07, 09, 11, 13, 15
CO-GENERATION:	OFF
Powers, Pf and cosφ selected:	P1
	Q1i
	Q1c
	S1
	Pf1
	dpf1
Energies:	Ea1
	Eri1
	Erc1

POWER & ENERGY

✓ ANALYZER CONFIG:

System:	SINGLE
Frequency:	50Hz
Current Range:	not modified
Clamp Type:	STD
TV Ratio:	not modified
Password:	not modified

✓ RECORDER CONFIG:

Start:	MANU (the recording is started 1 minute after pressing the **START/STOP** key)
Stop:	MANU
Integration period:	15min
Recording of harmonics:	OFF
Recording of Voltage anomalies (voltage Dips and Surge) :	OFF
Selected voltages:	V1
Selected currents:	I1
CO-GENERATION:	ON
Powers, Pf and cosφ selected:	P1
	Q1i
	Q1c
	S1
	Pf1
	dpf1
Energies:	Ea1
	Eri1
	Erc1

By pressing **START/STOP** the recording of the selected parameters is started according to the settings made for each Typical Configuration. The rotary switch position does not affect the recording setting.

10.3. DURING A RECORDING

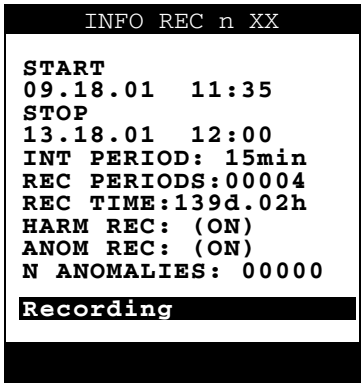
If during a recording the external power supply is de-energised, the instrument will continue the recording using the internal battery power until the batteries are exhausted (the data stored up to the point the instrument shuts down won't get lost). For this we recommend you **ALWAYS insert a new set of batteries before a long recording**.

The instrument uses sophisticated algorithms to prolong the battery life. Particularly if the instrument is recording or is measuring energy (and the external power supply is not connected), after about 5 minutes from the last key pressure or switch rotation the instrument starts a special procedure to save the batteries ("ECONOMY MODE"): the instrument keeps recording but the display is turned off.

During a recording the following are disabled:
- ✓ **AUTOPOWER OFF function**
- ✓ **ON/OFF key**
- ✓ **HOLD key**
- ✓ **SAVE key**

10.3.1. MENU key

If you press the **MENU** key during a recording the following screen will appear:



This screen includes:

1. START Date and Time
2. STOP Date and Time (or Manual).
3. Integration Period
4. Actual Number of Elapsed Integration Periods
5. Actual Recording Time
6. Status of Harmonic Flag
7. Status of Voltage Anomalies Flag
8. Number of Voltage anomalies occurred during the recording

10.3.2. Rotary Switch during a recording

If you move the rotary switch during a recording the following screen will appear:

This screen means that a recording is running but the actual rotary switch position does not correspond to this.

The instrument will continue to record.

10.4. STOPPING A RECORDING OR AN ENERGY MEASUREMENT

The instrument uses a protective routine to avoid the risk of being disturbed or interrupted during a recording or an energy measurement. Once a recording or a direct energy measurement (see paragraph 8.7.2) has been started (with the option PASSWORD enabled), after about 3 minutes from the last key pressure or switch rotation it won't be sufficient to press START/STOP (if a recording is running) or **F2** (if an energy measuring is running) to stop the recording, it will be necessary to insert the password.
In order to insert the password (which is not changeable), press the multifunction keys in the following sequence (within 10 seconds):

F1, **F4**, **F3**, **F2**

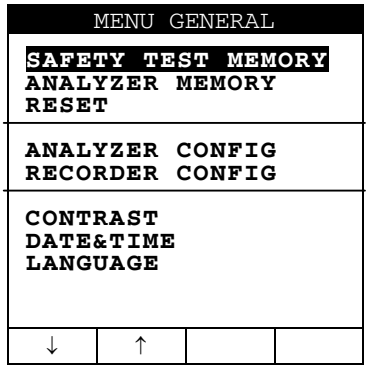
In order to enable/disable this option see paragraph 8.1.

If a wrong password is inserted, the instrument will display an error message and will repeat the request.

If no key is pressed after about 10 seconds the instrument returns back to the original screen.

11. INSTRUMENT'S MEMORY

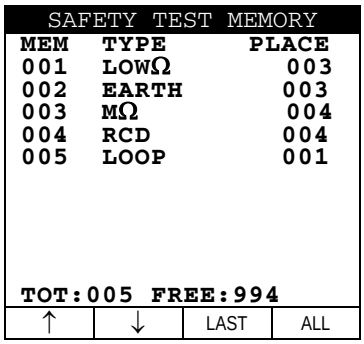
By pressing the **MENU** key the following screen will be displayed:



It's not possible to enter the **MENU** during a recording or a Real Time Energy measurement.

11.1. SAFETY TEST MEMORY

Selecting the SAFET TEST MEMORY item and pressing ENTER the instrument displays the following screen:



Example of SAFETY TEST MEMORY screen

- ✓ MEM: **Order Number of the measurement**
- ✓ TYPE: Measurement TYPE
- ✓ PLACE: Mnemonic parameter associated by User to Measurement
- ✓ TOT: Total Number of Measurements
- ✓ FREE: Available Memory Location

Following keys are enabled:

- ☞ **F1**, **F2**: to select the Measurement.
- ☞ **F3**: to cancel the last recording performed.
- ☞ **F4**: to cancel all the recordings performed.
- ☞ **ENTER**: to see the measurement results of the selected test
- ☞ **ESC**: to quit this mode

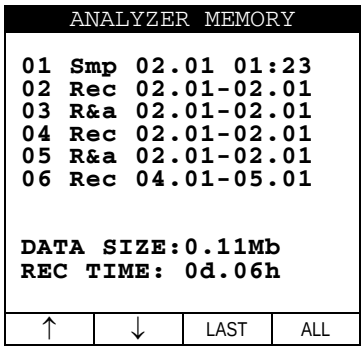
11.2. ANALYZER MEMORY

This option permits you to display:

- ✓ The present content of the instrument memory
- ✓ The size of the memorised data
- ✓ The residual space available for future recordings (expressed in days and hours)

All the stored data can be displayed and analyzed only downloading the data to a PC with the operating software.

After selecting "ANALYZER MEMORY" from the Main Menu the screen below will be displayed



Example of ANALYZER MEMORY screen

- ✓ Rec: **recordings** effected with respective Start and Stop dates expressed in the format "day. month" (start) – "day. month" (stop) ***without*** Voltage Sag and Surge detection.
- ✓ R&a: **recordings** effected with respective Start and Stop dates expressed in the format "day. month" (start) – "day. month" (stop) ***with*** Voltage Anomalies (Sag and Surge) detection.
- ✓ Smp: values of the **samples** of voltage and current stored by pressing SAVE.
- ✓ DATA SIZE: dimensions of the data saved in the instrument memory.
- ✓ REC TIME: amount of memory available, calculated on the basis of the parameters selected for recording, therefore the most complete one (expressed in the format "days. hours") to make recordings.

The maximum quantity of Rec + R&a + Smp which can be contained by the instrument is **35.**

Following keys are enabled:

- ☞ **F1**, **F2**: (only if the quantity of Rec+R&a+Smp is higher than 7) to run over all the recordings stored in the instrument memory.
- ☞ **F3**: to cancel the last recording performed.
- ☞ **F4**: to cancel all the recordings performed.
- ☞ **ESC**: to quit this mode

12. CONNECTING THE INSTRUMENT TO A PC

In order to connect the instrument to a PC you must connect the Optical serial cable that is shipped with the instrument to a PC COM port.

The available transmission speeds are the following:

9600, 19200, 57600 (default value)

The value of the transmission speed (Baud Rate) is displayed on the initial screen (immediately after turning on the instrument, see paragraph 4.2). The value of this parameter can be modified only with the management software.

For download instructions please refer to software help file.

In order to transfer the memorized data from the instrument to the PC the following procedure must be followed (after software installation):

1. **Switch ON the instrument and wait until the initial screen disappears (the rotary Switch position is not relevant).**
2. **Connect the Optical serial output of the instrument to the serial output of the PC through the Original Optical serial cable.**
3. **Run the program**
4. **Select the "Download" command**
5. **Refer to software help ON Line for further instructions.**

13. MAINTENANCE

13.1. GENERAL INSTRUCTION

The tester you have purchased is a precision instrument. Strictly follow the instructions for use and storage reported in this manual to avoid any possible damage or danger during use.
Do not use this tester under unfavourable conditions of high temperature or humidity. Do not expose to direct sunlight.
Be sure to turn off the tester after use. If the instrument is not to be used for a long period you are recommended to remove batteries to avoid acid leakage which may damage the internal circuits of the instrument.

13.2. BATTERY REPLACEMENT

The symbol shows the battery charge: If it is completely "black" the batteries are fully charged, while the symbol indicates flat batteries. When the batteries are too low to execute the test, the instrument will show a warning message.
In this case interrupt testing and replace batteries following the procedure for battery replacement. **The instrument is capable of keeping the data stored even though batteries are not installed. The Instrument Date and Time settings are not lost if you change the batteries within 24hours.**

⚠ **CAUTION:** Only skilled technicians can perform this operation. Before replacing batteries make sure that all test leads have been **disconnected** from input terminals.

1. Switch OFF the instrument.
2. Remove all the test leads from the input terminals.
3. Unscrew the fixing screw from the battery compartment cover and remove it.
4. Remove all batteries replacing them with 6 new ones of the same type (1.5V – LR6 – AA – AM3 – MN 1500) respecting the polarity signs.
5. Fix the screw on the battery compartment cover. Then put the holster on.

13.3. INSTRUMENT CLEANING

Use a soft dry cloth to clean the instrument. Never use wet cloths, solvents, water, etc.

13.4. END OF LIFE

Caution: this symbol indicates that equipment and its accessories shall be subject to a separate collection and correct disposal

14. TECHNICAL SPECIFICATIONS

14.1. TECHNICAL FEATURES

Accuracy is indicated as [% of reading + number of digits]. It refers to the following atmospheric conditions: a temperature of 23°C ± 5°C with a relative humidity < 60%.

14.1.1. Safety Test functions

- **LOWΩ: 200mA CONTINUITY TEST (AUTO, RT+, RT- MODE)**

Range [Ω]	Resolution [Ω]	Accuracy(*)
0.01 - 9.99 10.0 - 99.9	0.01 0.1	±(2% Reading + 2 digit)

(*) After Test leads calibration

Test Current > 200mA DC per R≤5Ω (Test leads included)
Resolution for Test current: 1mA
Open Circuit Voltage 4V ≤ V0 ≤ 24V

- **MΩ: INSULATION TEST**

Test Voltage [V]	Range [MΩ]	Resolution [MΩ]	Accuracy
50	0.01 - 9.99	0.01	±(2% Reading + 2 digit) if V/R>1µA
	10.0 - 49.9	0.1	
	50.0 - 99.9	0.1	±(5% Reading + 2 digit) if V/R≤1µA
100	0.01 - 9.99	0.01	±(2% Reading + 2 digit) if V/R>1µA
	10.0 - 99.9	0.1	
	100.0 - 199.9	0.1	±(5% Reading + 2 digit) if V/R≤1µA
250	0.01 - 9.99	0.01	±(2% Reading + 2 digit) if V/R>1µA
	10.0 - 199.9	0.1	
	200 - 249	1	
	250 - 499	1	±(5% Reading + 2 digit) if V/R≤1µA
500	0.01 - 9.99	0.01	±(2% Reading + 2 digit) if V/R>1µA
	10.0 - 199.9	0.1	
	200 - 499	1	
	500 - 999	1	±(5% Reading + 2 digit) if V/R≤1µA
1000	0.01 - 9.99	0.01	±(2% Reading + 2 digit) if V/R>1µA
	10.0 - 199.9	0.1	
	200 - 999	1	
	1000 - 1999	1	±(5% Reading + 2 digit) if V/R≤1µA

Open circuit Test Voltage <1.3 x Nominal Test Voltage
Short Circuit Current <6.0mA with 500V Test Voltage
Nominal Test Current 500V >2.2mA with 230kΩ
other >1mA with 1kΩ*Vnom

- **RCD: TEST ON RCD DEVICES**

Nominal Test Current (IΔN) 10mA, 30mA, 100mA, 300mA, 500mA
RCD type AC, A General e Selective
Phase to Earth Test Voltage 100V - 250V 50 Hz
Frequency 50Hz ± 0.5Hz

- Tripping Time Measurement $t_{\Delta N}$

Range [ms]		Resolution [ms]	Accuracy
½ $I_{\Delta N}$, $I_{\Delta N}$	1 - 999	1	±(2%Reading+2digit)
2 $I_{\Delta N}$	1 - 200 general		
	1 - 250 selective		
5 $I_{\Delta N}$ RCD	1 - 50 general		
	1 - 160 selective		

- Contact Voltage Ut

Range [V]	Resolution [V]	Accuracy
0 - $2U_{t\,lim}$	0.1	- 0%, +(5% Reading + 3digit)

Ut LIM (UL): 25V o 50V

- Global Earth Resistance Measurement (avoiding RCD tripping)

Range [Ω]	Resolution [Ω]	Accuracy IΔN
1 - 1999	1	- 0%, +(5% Reading + 3digit)

Test Current 0.5 IΔN set

- Tripping Current Measurement

IΔN	RCD Type	Range $I_{\Delta N}$ [mA]	Resolution [mA]	Accuracy IΔN
IΔN ≤ 10mA	AC	(0.5 - 1.4) $I_{\Delta N}$	0.1 $I_{\Delta N}$	- 0%, +5% $I_{\Delta N}$
	A	(0.5 - 2.4) $I_{\Delta N}$		
IΔN > 10mA	AC	(0.5 - 1.4) $I_{\Delta N}$		
	A	(0.5 - 2) $I_{\Delta N}$		

- **FREQUENCY MEASUREMENT**

Range [Hz]	Resolution [Hz]	Accuracy
47.0 - 63.6	0.1	±(0.1%Reading+1 digit)

RCD and LOOP function are active only for 50Hz ± 0,5Hz frequency

- **VOLTAGE MEASUREMENT (RCD, LOOP, PHASE ROTATION)**

Range [V]	Resolution [V]	Accuracy
0 - 460V	1	±(3%Reading + 2digit)

- **LOOP P-P, P-N: LINE IMPEDANCE MEASUREMENT (Phase - Phase, Phase - Neutral)**

Range [Ω]	Resolution [Ω]*	Accuracy
0.01 - 9.99	0.01	±(5% Reading + 3digit)
10.0 - 199.9	0.1	

(*) 0.1 mΩ on range 0.0 - 199.9 mΩ (with IMP57)

Peak value of the Test current	127V 3.65A
	230V 6.64A
	400V 11.5A
Voltage Range (Phase - Phase, Phase - Neutral)	100 - 250/ 100 - 440V
Frequency	50Hz ± 0.5Hz

- **LOOP P-PE: FAULT LOOP IMPEDANCE MEASUREMENT (Phase - Earth)**

Range [Ω]	Resolution [Ω]*	Accuracy
0.01 - 19.99	0.01	±(5% Reading + 3digit)
20.0 - 199.9	0.1	
200 - 1999	1	

(*) 0.1 mΩ on range 0.0 - 199.9 mΩ (with IMP57)

Peak value of the Test current:	127V 3.65A
	230V 6.64A
Voltage Range (Phase - Earth)	100 - 250V
Frequency	50Hz ± 0.5Hz

- **LOOP $R_{a\ 15mA}$: FAULT LOOP IMPEDANCE MEASUREMENT without RCD Tripping (Phase - Earth)**

Range [Ω]	Resolution [Ω]	Accuracy
1 ÷ 1999	1	- 0%, +(5% Reading + 3digit)

Test Current	15mA
Voltage Range (Phase - Earth)	100 - 250V 50Hz

- **EARTH: GROUND RESISTANCE MEASUREMENT WITH EARTH RODS**

Range RE [Ω]	Resolution [Ω]	Accuracy
0.01 - 19.99	0.01	±(5% Reading + 3 digit)
20.0 - 199.9	0.1	
200 - 1999	1	

Test Current	<10mA - 77.5Hz
Open circuit Test Voltage	<20V RMS

- **RESISTIVITY MEASUREMENT**

Range ρ	Resolution	Accuracy
0.60 -19.99 Ωm	0.01 Ωm	±(5% Reading + 3 digit)
20.0 - 199.9Ωm	0.1Ωm	
200 - 1999Ωm	1 Ωm	
2.00 - 99.99kΩm	0.01 kΩm	
100.0 - 125.6kΩm(*)	0.1 kΩm	

(*) setting distance = 10m

Test Current	<10mA – 77.5Hz
Open circuit Test Voltage	<20V RMS

14.1.2. ANALYSER and AUX functions

- **VOLTAGE MEASUREMENT – SINGLE PHASE SYSTEM (AUTORANGE)**

Range [V]	Resolution [V]	Accuracy	Input Impedance
15 - 310V	0.2V	±(0.5% Reading+2digit)	300kΩ (Phase - Neutral) 300kΩ (Phase - Phase)
310 - 600V	0.4V		

- **VOLTAGE SAG AND SURGE DETECTION – SINGLE PHASE SYSTEM (MANUAL RANGE)**

Range [V]	Resolution (Voltage)	Resolution (Time)	Accuracy (Voltage)	Accuracy (rif. 50Hz) (Time)	Input Impedance
15 - 310V	0.2V	10ms (½ period)	±(1.0% Reading+2digit)	± 10ms (½ period)	300kΩ (Phase - Neutral) 300kΩ (Phase - Phase)
30 - 600V	0.4V				

- **CURRENT MEASUREMENT – SINGLE PHASE SYSTEM (AUTORANGE)**

Range [V]	Resolution [mV]	Accuracy	Input Impedance	**Overload** Protection
0.005 - 0.26V	0.1	±(0.5% Reading+2digit)	200kΩ	5V
0.26 - 1V	0.4			

(*): Example: with a 1000A/1V full scale clamp , the instrument detect only current higher than 5A

- **POWER MEASUREMENT – SINGLE PHASE SYSTEM (AUTORANGE)**

Quantity	Range	Accuracy	Resolution
ACTIVE POWER	0 - 999.9W 1 - 999.9kW 1 - 999.9MW 1000 - 9999MW	±(1.0%Reading+2digit)	0.1W 0.1kW 0.1MW 1MW
REACTIVE POWER	0 - 999.9VAR 1 - 999.9kVAR 1 - 999.9MVAR 1000 - 9999MVAR		0.1VAR 0.1kVAR 0.1MVAR 1MVAR
APPARENT POWER	0 - 999.9VA, 1 - 999.9kVA, 1 - 999.9MVA 1000 - 9999MVA		0.1VA 0.1kVA 0.1MVA 1MVA
ACTIVE ENERGY (Classe2 EN61036)	0 - 999.9Wh, 1 - 999.9kWh, 1 - 999.9MWh 1000 - 9999MWh		0.1Wh 0.1kWh 0.1MWh 1MWh
REACTIVE ENERGY (Classe3 IEC1268)	0 - 999.9VARh, 1 - 999.9kVARh, 1 - 999.9MVARh 1000 - 9999MVARh		0.1VARh 0.1kVARh 0.1MVARh 1MVARh

- **Cos φ MEASUREMENT – SINGLE PHASE SYSTEM**

Cos φ	Resolution	Accuracy [°]
0.20	0.01	0.6
0.50		0.7
0.80		1.0

- **VOLTAGE AND CURRENT HARMONICS MEASUREMENT – SINGLE PHASE SYSTEM**

Range	Accuracy	Resolution
DC – 25H	±(5% + 2 digit)	0.1V / 0.1A
26H – 33H	±(10% + 2 digit)	
34H – 49H	±(15% + 2 digit)	

Harmonics values are null under fixed threshold:

- DC: its values are null if it is < 2%of Fundamental or is <2% of Full Scale clamp
- 1st Current Harmonic: its values are null if it is < 0.2% Full Scale clamp
- 2nd - 49th : its values are null if it is < 2% of fundamental or is <2% of Full Scale clamp

- **LEAKAGE CURRENT MEASUREMENT**

Range (*)	Resolution [mA]	Accuracy	Input Impedance	Overload Protection
0.5 - 999.9mA	0.1mA	±(5% Reading + 2digit)	200kΩ	5V

(*): During a recording the instrument will detect only Current > 5mA with Resolution 1mA

14.2. STANDARDS

14.2.1. General

Safety	EN 61010-1 + A2 (1997)
Protection classification	Class 2 - Double Insulation
Pollution degree	2
Degree of Protection:	IP50
Over-Voltage Category	CAT II 600V~ / 350V~ (phase –earth) CAT III 600V~ / 300V~ (phase –earth)
Usage:	Indoor; max height 2000m
EMC	EN61326-1 (1997) + A1 (1998)

The Instrument complies with European Guidelines for CE mark

14.2.2. Safety Test

LOWΩ (200mA):	IEC 61557-4
MΩ:	IEC 61557-2
RCD:	IEC 61557-6
LOOP P-P, P-N, P-PE:	IEC 61557-3
PHASE SEQUENCE:	IEC 61557-7
EARTH:	IEC 61557-5

14.2.3. ANALYSER

Voltage Sag and Surge	EN50160
Alternating Current Static Watt-hour meters for Active Energy	EN61036 (CLASS 2)
Alternating Current Static VAR-hour meters for Reactive Energy	IEC1268 (CLASS 3)

14.2.4. AUX

14.3. GENERAL SPECIFICATIONS

14.3.1. Mechanical Data

Dimensions	225 (L) x165 (W) x 105 (H) mm
Weight	1295g approx (including batteries) 1150g approx (excluding batteries)

14.3.2. Power supply

Batteries	6 x 1.5-LR6-AA-AM3-MN 1500	
Battery Life:	LOWΩ:	approx: 800 tests
	MΩ:	approx: 500 tests
	RCD AC and A Type:	approx: 1000 tests
	LOOP P-P, P-N, P-PE	approx: 1000 tests
	Ra⏚:	approx: 1000 tests
	EARTH:	approx: 1000 tests
	PHASE SEQUENCE:	approx: 1000 tests
	AUX (recording):	approx: 20 Hours
	ANALYSER (recording):	approx: 20 Hours
External Power Supply Adapter (optional)	Code MAR#### (only for ANALYSER and AUX func)	

14.3.3. Display

Display Type	Graphic with Backlight
Resolution	128 x128
Visible Area	73mm x 73mm

14.3.4. Memory

Safety Test Memory	999 measurements
ANALYSER:	2MByte (with 63 channels select and Integration Period = 15min ->more than 30 days).

14.4. ENVIRONMENT

Reference Temperature	23° ± 5°C
Working Temperature Range	0° - 40°C
Working Humidity	< 80%
Storage Humidity Range	-10° - + 60°C
Storage Humidity	< 80%

14.5. ACCESSORIES

Standard accessories

Description	Code
• GB 13A cable with 3 terminals • Set with 4 cables (2m), 4 crocodiles, • Management Software + RS232 Optical-Serial Cable • Zip Carrying Case • Calibration Certificate ISO9000 • User's Manual	TOPLINK

Optional Accessories

Description	Code
• Set with 4 cables and 4 earth rods • External Power Supply Adapter • Set for carrying Belt • Leakage Current clamp 1-100-1000A/1V, diameter 54 mm	MAR####

15. SERVICE

15.1. WARRANTY CONDITIONS

This instrument is guaranteed against any defect in material and manufacturing in compliance with the general sales terms and conditions. Throughout the period of guarantee all defective parts may be replaced and the manufacturer reserves the right to repair or replace the product.

If the instrument is to be returned to the after-sales service or to a dealer transportation costs are on the customer's behalf. Shipment shall be however agreed upon.
A report must always be enclosed with a rejected product stating the reasons for its return.
To ship the instrument, use only the original packaging material; any damage that may be due to non-original packing shall be charged to the customer.
The manufacturer declines any responsibility for damages caused to persons and/or objects.

Warranty is not applied in the following cases:

- ☞ Any repair that might be necessary as a consequence of a misuse of the instrument or of its use with non-compatible devices.
- ☞ Any repair that might be necessary as a consequence of improper packaging.
- ☞ Any repair that might be necessary as a consequence of service actions carried out by unauthorised personnel.
- ☞ Any modification of the instrument carried out without the authorisation of the manufacturer.
- ☞ Use not provided for in the instrument's specifications or in the instruction manual.

The content of this manual cannot be reproduced in any form whatsoever without prior authorisation of the manufacturer.

NOTE: All our products are patented and their trade marks registered. The manufacturer reserves the right to modify the product specifications and prices if this is aimed at technological improvements

15.2. SERVICE

If the instrument does not operate properly, before contacting the after-sales service check cables as well as test leads and batteries, replace them if necessary.
Should the instrument still operate improperly check that the operation procedure is correct and conforms to the instructions given in this manual.

If the instrument is to be returned to the after-sales service or to a dealer transportation costs are on the customer's behalf. Shipment shall be however agreed upon.
A report must always be enclosed to a rejected product stating the reasons of its return.
To ship the instrument use only the original packaging material; any damage that may be due to no-original packing shall be charged to the customer.

16. PRACTICAL REPORTS FOR ELECTRICAL TESTS

16.1. Continuity Test On Protective Conductors

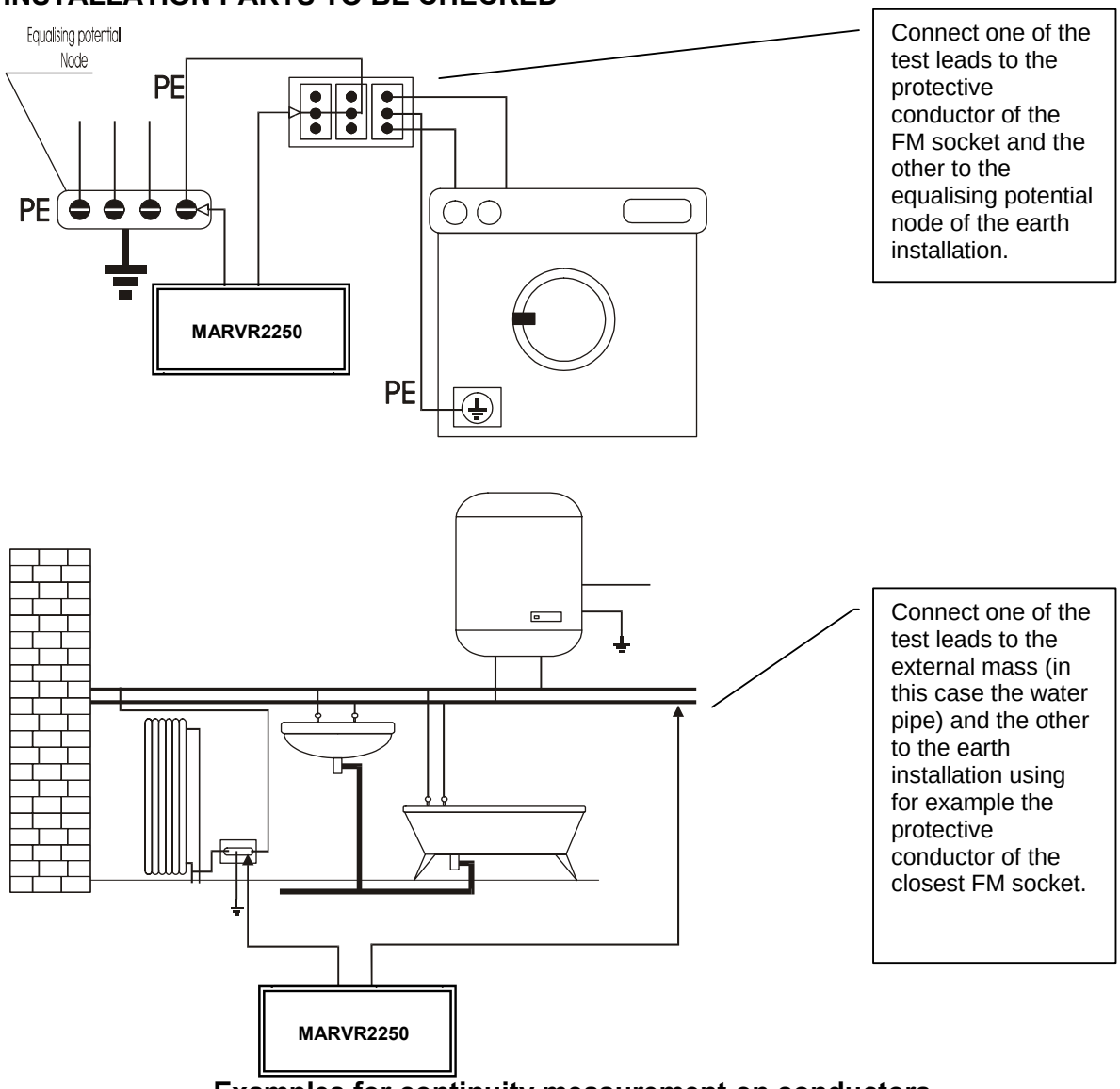
PURPOSE OF THE TEST

Check the continuity of:

- ☞protective conductors (PE), main equalising potential conductors (EQP), secondary equalising potential conductors (EQS) in TT and TN-S systems.
- ☞Neutral conductors having functions of protective conductors (PEN) in TN-C system.

NOTE: This test is to be preceded by a visual check verifying the existence of yellow-green protective and equalising potential conductors as well as compliance of the sections used with the standards' requirements.

INSTALLATION PARTS TO BE CHECKED



Examples for continuity measurement on conductors

Check the continuity among:
a) Earth poles of **all** the plugs and earth collector or node.
b) Earth terminals of class I instruments (Boiler etc.) and earth collector or node.
c) Main external masses (water, gas pipes etc.) and earth collector or node.
d) Auxiliary external masses to the earth terminal.

ALLOWABLE VALUES

The standards CEI 64-8/6 do not give any indication on the maximum resistance values which cannot be overcome, in order to be able to declare the positive outcome of the continuity test.

The standard CEI 64-8/6 simply requires that the instrument in use warns the operator if the test was not carried out with a **current of at least 0.2A** and an **open circuit voltage ranging from 4 V to 24 V**.

The resistance values can be calculated according to the sections and lengths of the conductors under test, anyway if the instrument detects values of some ohm the test can be considered as passed.

16.2. Insulation Resistance Measurement of the Electrical Installations (250Vdc, 500Vdc, 1000Vdc)

PURPOSE OF THE TEST

Check that the insulation resistance of the installation complies with the requirements of standards CEI 64-8/6.

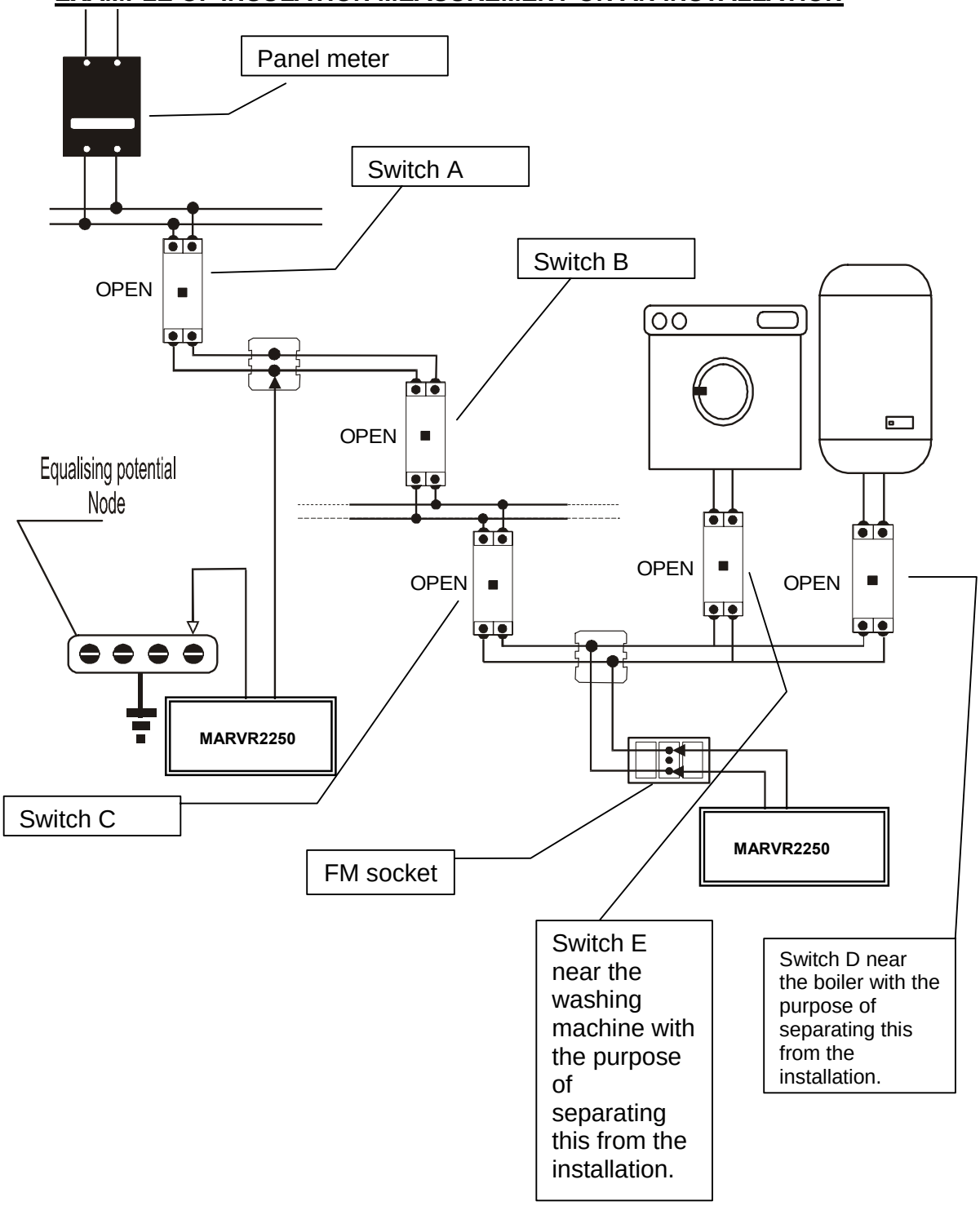
NOTA: This test is to be performed on an open circuit with any load disconnected.

☞ INSTALLATION PARTS TO BE CHECKED

a) Between each active conductor and the earth (the neutral conductor is considered an active conductor except in the case of TN-C systems where it is considered part of the earth (PEN).
During this measurement all active conductors can be connected to each other, in case the measurement result does not fall within the standard limits the test is to be repeated for each single conductor.

b) Among active conductors.
The standard CEI 64-8/6 recommends checking the insulation among the active conductors when this is possible (ATTENTION).

☞ **EXAMPLE OF INSULATION MEASUREMENT ON AN INSTALLATION**



Insulation measurements on an installation.

A procedure indicating how to perform the insulation resistance measurement on an installation is reported in the following table:

Procedure for insulation resistance measurement referred to the previous picture:

Switch situation		Point under test	Measurement result	Judgement on the installation
1	Turn the switch A, D and E off	Perform the measurement on switch A	Se R ≥ R_{LIMITE}	☺ **OK** (end of the test)
			Se R< R_{LIMITE}	Proceed ☞ 2
2	Turn the switch B off	Perform the measurement on switch A	Se R ≥ R_{LIMITE}	Proceed ☞ 3
			Se R< R_{LIMITE}	☹ INSTALLATION NOT COMPLYING WITH STANDARDS
3		Perform the measurement on switch B	Se R ≥ R_{LIMITE}	☺ **OK** (end of the test)
			Se R< R_{LIMITE}	Proceed ☞ 4
4	Turn the switch C off	Perform the measurement on switch B	Se R ≥ R_{LIMITE}	Proceed ☞ 5
			Se R< R_{LIMITE}	☹ INSTALLATION NOT COMPLYING WITH STANDARDS
5		Perform the measurement on switch C	Se R ≥ R_{LIMITE}	☺ **OK** (end of the test)
			Se R< R_{LIMITE}	☹ INSTALLATION NOT COMPLYING WITH STANDARDS

Table5: Table with procedure steps for insulation measurement referred to the installation reported in Insulation measurements on an installation.

Note The switches D and E are those installed near the load having the purpose of separating it from the installation. In case the above said RCDs do not exist it is necessary to disconnect the users from the installation before performing the insulation resistance test.

ATTENTION:
If the installation includes electronic devices, disconnect them from the installation and in case this is impossible only the test "a" is to be performed, that is to say between active conductors (which in this case SHALL be connected together) and the earth.

ALLOWABLE VALUES

The values of test voltage and minimum insulation resistance are reported in the following table (CEI64-8/6 Tab. 61A):

Rated circuit voltage (V)	Test voltage (V)	Insulation resistance (MΩ)
SELV and PELV*	250	≥0.250
Up to 500 V included, except for the above circuits.	500	≥0.500
Over 500 V	1000	≥1.000
* In the new standards the terms SELV and PELV replace the old definitions "safety low voltage" or "functional".		

Table 6: Table summarising the test voltage values and relative limit values for the most common types of test.

NOTE:

- ☞ If the circuit is quite large the conductors running side by side make up a capacity which is to be charged by the instrument in order to carry out a correct measurement; in this case it is recommended to keep the **GO** key pressed (in case a test is performed under manual mode) until the result gets stable.

- ☞ **ATTENTION**: When you effect measurements among active conductors it is essential to disconnect all the users (alarm lamps, intercom transformers, boilers etc) otherwise the instrument will measure their resistance instead of the installation insulation. Moreover any insulation resistance test among active conductors could damage them.

The indication **"> 1999MΩ"** or **"o.r."** (out of range) warns that the insulation resistance measured by the instrument is higher than the maximum resistance limit (see technical specifications); this result is obviously far higher than the minimum limits of the above table therefore if during a test this symbol is displayed the insulation of that point is to be considered in compliance with standards.

16.3. Check of the Circuit Separation

PURPOSE OF THE TEST

The test, to be performed in case the protection is realised through separation (64-8/6 612.4, SELV or PELV or electrical separation), shall check that the insulation resistance measured according to the indications below (depending on the separation type) complies with the limits reported in the table relative to the insulation measurements.

☞ INSTALLATION PARTS TO BE CHECKED

- **SELV** system (Safety Extra Low Voltage):

✓ Measure the resistance between the active parts of the circuit under test (separate) and the active parts of the other circuits.
✓ Measure the resistance between the active parts of the circuit under test (separate) and the earth.

The resistance shall not be lower than 0.25MΩ with a test voltage of 250VDC.

- **PELV** system (Protective Extra Low Voltage):

✓ Measure the resistance between the active parts of the circuit under test (separate) and the active parts of the other circuits.

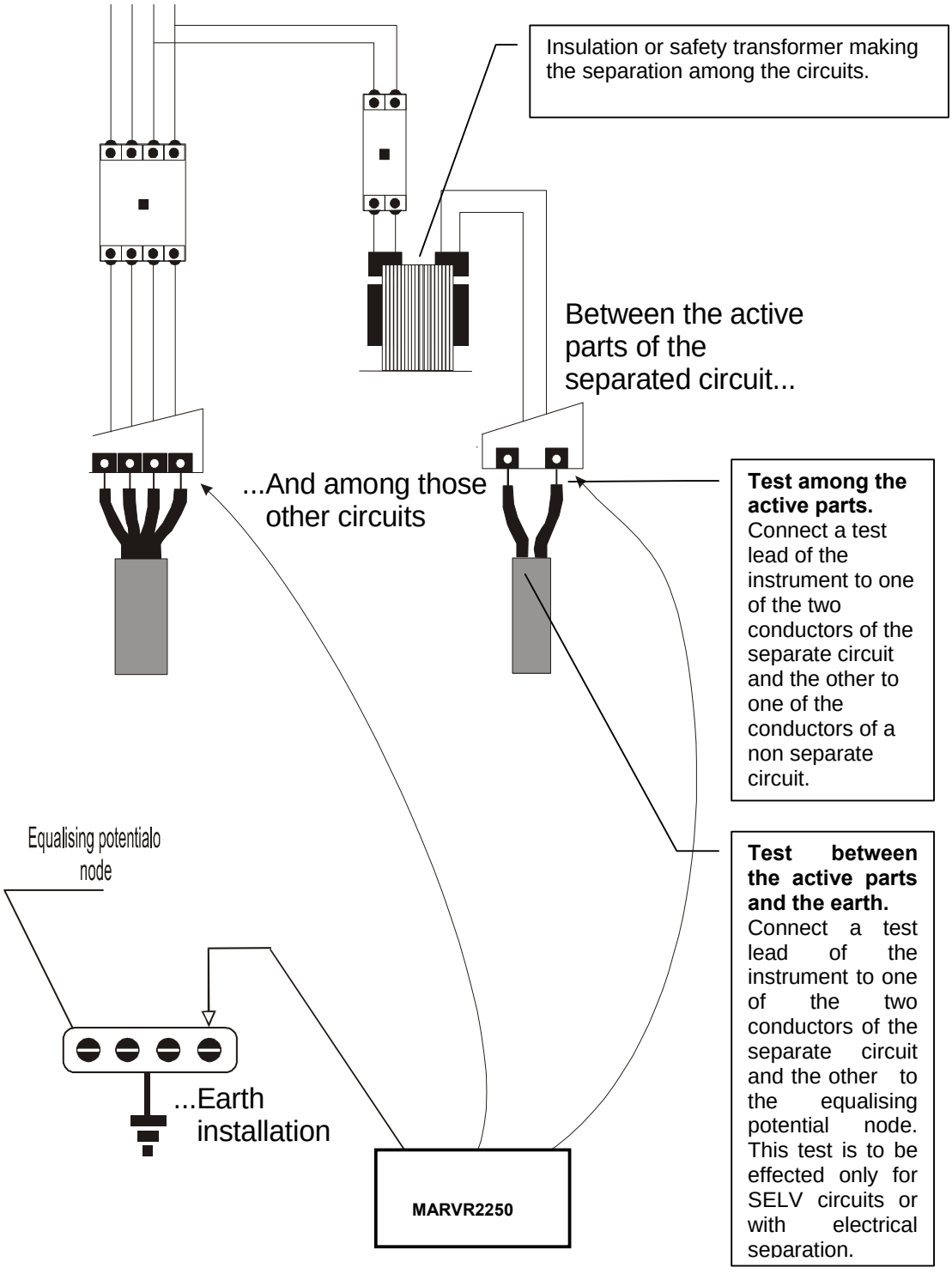
The resistance shall not be lower than 0.25MΩ with a test voltage of 250VDC.

- **Electrical separation**:

✓ Measure the resistance between the active parts of the circuit under test (separate) and the active parts of the other circuits.
✓ Measure the resistance between the active parts of the circuit under test (separate) and the earth.

The resistance shall not be lower than 0.5MΩ with a test voltage of 500VDC and 1MΩ with a test voltage of 1000VDC.

☞ EXAMPLE OF CHECKING THE SEPARATION AMONG ELECTRICAL CIRCUITS



Measurement of separation among the installation circuits

ALLOWABLE VALUES

The test result is positive when the insulation resistance indicates values higher or equal to those indicated in the table reported in the section relative to insulation tests.

Notes:

- **SELV** system: is a system of category zero or very low safety voltage featured by:

  ✓ Power supply: autonomous source (ex. batteries, small generator) or safety (ex. safety transformer).
  ✓ Protection separation to other electrical systems (double or reinforced insulation or a metal screen connected to the earth).
  ✓ There are no earthed points (insulated from the earth).

- **PELV** system: is a system of category zero or very low safety voltage featured by:

  ✓ Power supply: autonomous source (ex. batteries, small generator) or safety (ex. safety transformer).
  ✓ Protection separation to other electrical systems (double or reinforced insulation or a metal screen connected to the earth).
  ✓ There are earthed points (not insulated from the earth).

- **Electrical separation**: is a system featured by:

  ✓ Power supply: insulation transformer or autonomous source with equivalent features (ex. generator).
  ✓ Protection separation to other electrical systems (insulation not lower than that of the insulation transformer).
  ✓ Protection separation to the earth (insulation not lower than that of the insulation transformer).

16.4. Earth Resistance Measurement in TT Systems

PURPOSE OF THE TEST

Check that the RCD is co-ordinated with the earth resistance value. It is not possible to assume an earth resistance value as reference limit (for example 20Ω according to the art. 326 of DPR 547/55) when controlling the test result, while it is necessary to check every time that the co-ordination complies with the requirements of the standards.

☞ INSTALLATION PARTS TO BE CHECKED

The earth installation under working conditions. The check is to be effected without disconnecting the earth plates.

ALLOWABLE VALUES

The earth resistance value measured shall meet the following relation:

$$R_A < 50 / I_a$$

Where: **R_A**= Resistance of the earth installation, the value can be set with the following measurements:

- Earth resistance with three-wire volt-ampere method.
- Fault loop impedance (see (*))
- Two-wire earth resistance (see (**))
- Two-wire earth resistance in the socket (see (**))
- Earth resistance obtained by the measurement of contact voltage U_t (See (**)).
- Earth resistance obtained by the tripping time test of the RCDs (A, AC), RCDs S (A, AC) (see (**)).

I_a= Tripping current in 5s of the RCD; rated tripping current of the RCD (in the case of RCD S 2 $I_{\Delta n}$).

50= Safety limit voltage (reduced down to 25V in special rooms).

(*) If the installation is protected by an RCD the measurement shall be performed upstream or downstream the RCD short circuiting it to avoid its tripping.

(**) These methods, even though not provided by the standards CEI 64.8, provide values resulted to be indicative of the earth resistance.

☞ **EXAMPLE FOR EARTH RESISTANCE TEST**

Let's assume an installation protected by a 30 mA RCD. Let's measure the earth resistance using one of the methods quoted previously, to evaluate whether the installation resistance is complying with the standards in force and multiply the result by 0.03A (30 mA). If the result is lower than 50V (or 25V for special rooms) the installation can be considered as co-ordinated as it respects the above-said relation. When we face 30 mA RCDs (the most of civil installations) the maximum earth resistance allowed is 50/0.03=1666Ω permitting to use even simplified methods which even though they do not provide extremely precise values give a value approximate enough for the calculation of the co-ordination.

16.5. Working Test of RCDs (Rcd, Rcd/Dc, Rcd S, Rcd/Dc S)

PURPOSE OF THE TEST

Check (standards CEI 64-8 612.9, CEI 64-14 2.3.2.2.) whether general and selective RCDs have been installed and adjusted properly and whether they maintain their features over the time.

The check shall confirm that the RCD trips at a current I_{Δ} lower than its rated working current $I_{\Delta n}$ and that the tripping time meets, depending on the case, the following conditions:

- Does not exceed the maximum time provided by the standards in case of RCDs of general type (according to **Table 3**).
- Is included between the minimum tripping time and the maximum one in case of RCDs of selective type (according to **Table 3**).

The RCD test effected by means of the test key is aimed at preventing **"the gluing effect"** from compromising the working of the RCD which has been inactive for a long time; therefore this test is effected only to verify the mechanical working of the RCD and it does not permit to declare that the RCD is complying with the standards. According to a statistical survey the periodical check, once a month, of the RCDs by means of the test key reduces by one half the RCD fault rate, this test however detects only 24% of defective RCDs.

☞ **INSTALLATION PARTS TO BE CHECKED**

All the RCDs shall be tested when installed.
In the low voltage installations the test is recommended to grant an acceptable safety level.

For the medical rooms this check shall be effected periodically every six months on all RCDs according to the standards CEI 64-4 5.2.01 and CEI 64-13.

Note In this case the earth installation is not available. Perform the test connecting the instrument with one terminal on a conductor downstream of the RCD and one terminal on the other conductor upstream of the RCD itself.

ALLOWABLE VALUES

To compare the measurements make reference to the Table 5 reporting the limits for the tripping times. On each RCD it is necessary to effect: a test with leakage current in

phase with voltage and a leakage current phase shifted by 180° with respect to the voltage. The highest time is to be considered as significant result.

The test at ½$I_{\Delta n}$ SHALL NEVER cause the RCD tripping.

NOTE:

- Before performing the test at the RCD rated current the instrument carries out a test at ½$I_{\Delta n}$ to measure the contact voltage and the overall earth resistance; if during this test the RCD trips the indication l **"rcd"** is displayed. During this test the RCD may trip for three possible reasons:
  a) The RCD tripping current is lower than ½$I_{\Delta n}$.
  b) An earth plate is already present on the installation which added to the earth generated by the instrument causes the RCD tripping.
  c) There is no earth installation.
- If during measurement of contact voltage the voltage detected is higher than the safety value (50V or 25V) the test is interrupted; proceeding with the test under such conditions would mean to keep the contact voltage applied to all the metal masses connected to the earth for a too long time resulting to be dangerous.
- Among the test results of the RCD tripping time also the earth resistance value R_a is displayed in Ω, this value for the TN and IT systems is not to be considered while for the TT systems it is merely indicative.

16.6. Test of RCD Tripping Time (Rcd, Rcd/Dc)

PURPOSE OF THE TEST

Check the real tripping time of the general RCDs (it does not apply to the selective RCDs).

☞ **INSTALLATION PARTS TO BE CHECKED**

When facing RCDs with tripping current to be selected it is useful to perform this test to check the real RCD tripping current. For RCDs with fixed differential current this test can be performed to detect any leakage of the installation users.

In case the earth installation is not available effect the test connecting one instrument‘s terminal on a conductor downstream the RCD and one terminal on the other conductor upstream the RCD itself.

ALLOWABLE VALUES

The tripping current shall range from ½$I_{\Delta n}$ to $I_{\Delta n}$.

NOTE:

- Make reference to the notes of the previous chapter.
- To check whether significant leakage currents are present on the installation operate as follows:
  a) After deactivating all the loads perform the tripping current measurement and take note of the value.
  b) Activate the loads and effect a new measurement of the tripping current; if the RCD trip with a lower current, the installation leakage is the difference between the two tripping currents. If during the test “RCD" is displayed the installation leakage current added to the current for contact voltage measurement (½$I_{\Delta n}$) causes the RCD tripping.

16.7. Measurement of Short-Circuit Fault Impedance (Z_{pn}, Z_{pp})

PURPOSE OF THE TEST

Check that the tripping power of the RCD is higher than the maximum fault current of the installation.

☞ **INSTALLATION PARTS TO BE CHECKED**

The test shall be performed in the point where the short circuit current is the highest possible, usually immediately downstream of the RCD to be checked.
The test shall be performed between phase and phase (Z_{pp}) in the three phase installations and between phase and neutral (Z_{pn}) in the single-phase installations..

ALLOWABLE VALUES

Three-phase installations:

$$Pi > \frac{400}{Zpp} * \frac{2}{\sqrt{3}}$$

Single-phase installations:

$$Pi > \frac{230}{Zpn}$$

Note: P_i = tripping power of the RCD
Z_{pp} = impedance measured between phase and phase.
Z_{pn}= impedance measured between phase and neutral

16.8. Fault Loop Impedance Measurement (Phase – Earth)

PURPOSE OF THE TEST

The fault loop is the circuit of the current when there is a bad isolation of the electrical system toward earth. The fault loop is composed:

- Transformer coil impedance.
- The impedance of the line from the transformer to the fault.
- The impedance of the protective conductor from the conductive part to the neutral of the transformer.

When the instrument measure the impedance of the fault loop, the instrument will detect the prospective phase-PE short-circuit current so the operator can determine if the overload protection is appropriate.

ATTENTION: The resolution of the instrument is 10mΩ when the impedance value is inside (0.01 – 19.99)Ω, so use the instrument for measurements of impedance higher of 100mΩ.

☞ **POINTS TO BE CHECKED**

The test is necessary in TN or IT electrical system without RCDS.

ALLOWED VALUES

The following relation has to be fulfilled:

$$Z_S \leq U_o / I_a$$

Note: U_o= Phase-Earth Voltage.
Z_S = Impedance Phase-Earth.
I_a= tripping current of the overload protection in 5 seconds.

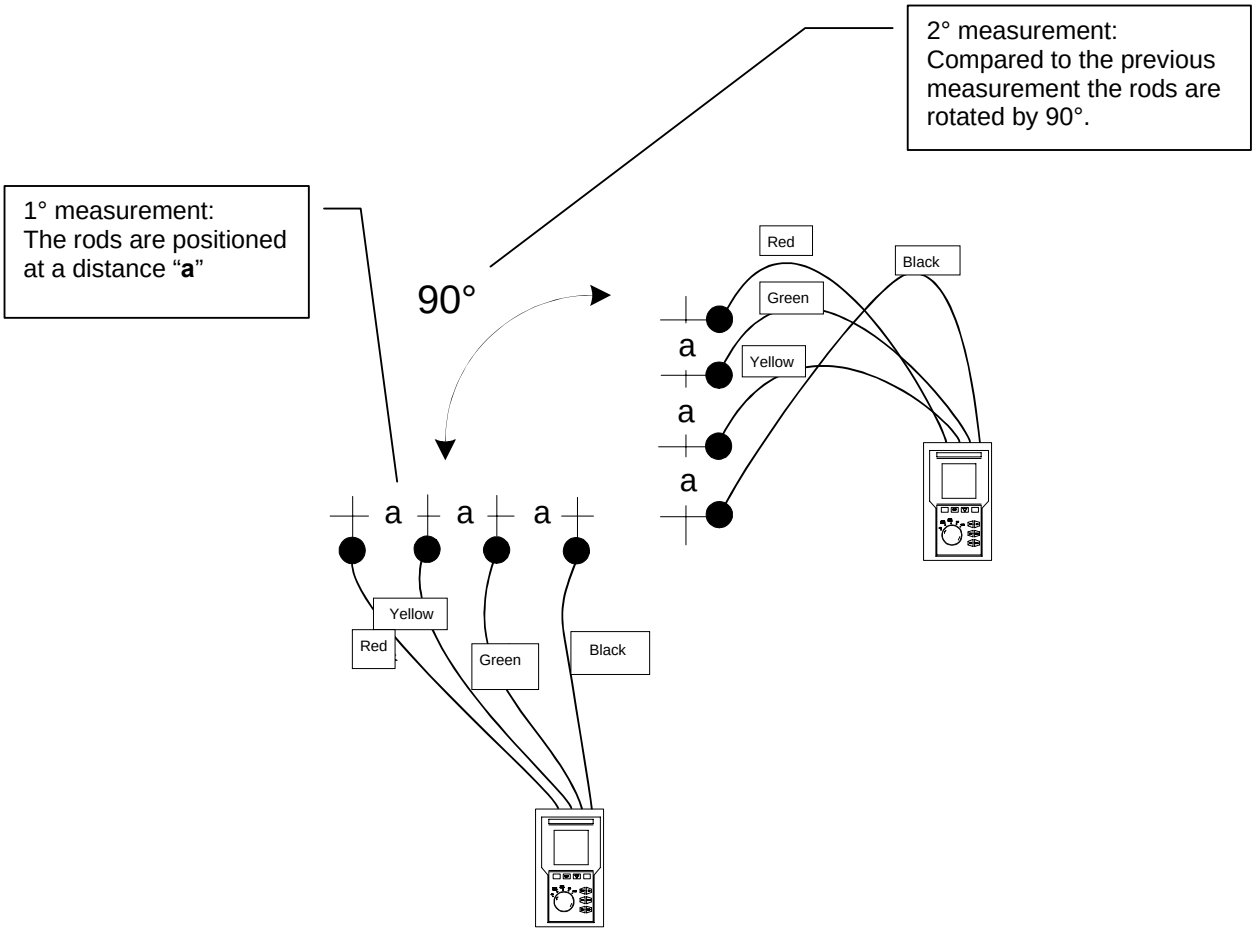
16.9. Earth Resistivity Measurement

PURPOSE OF THE TEST

This test aims at analyse the resistivity value of the ground in order to define the type of rods to be used.

EQUIPMENT PARTS TO BE TESTED

For the resistivity test admissible values do not exist. The various values measured by positioning the rods at growing distances "**a"** must be quoted in a graph. According to the resulting curve, suitable rods will be chosen. As the test result can be affected by metal parts buried (such as pipes, cables or other rods), in case of doubts take a second measurement positioning the rods at an equal distance "**a**", but rotating their axis by 90°.

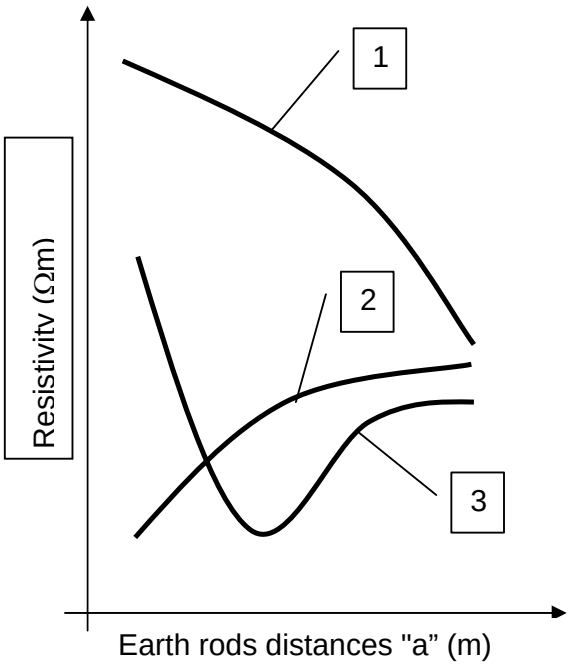


The resistivity value is calculated with the following formula:

$$\rho = 2\pi \mathbf{a} R$$

Where: ρ= specific resistivity of the ground
a= distance between the rods (m)
R= resistance measured by the instrument (Ω)

The measuring method allows defining of the specific resistance up to the depth corresponding approximately to the distance "**a**" between the rods. If you increase the distance "**a**" you can reach deeper ground layers and check the ground homogeneity. After several ρ measurements, at growing distances "**a**", you can trace a profile like the following ones, according to which the most suitable rod is chosen:



Curve1: as ρ decreases only in depth, it's possible to use only a rod in depth.

Curve2: as ρ decreases only until the depth A, it's not useful to increase the depth of the rod beyond A.

Curve3: even at a superior depth, ρ does not decrease, therefore a ring rod must be used.

APPROXIMATE EVALUATION OF THE CONTRIBUTION OF INTENTIONAL RODS (64-12 2.4.1)

The resistance of a rod Rd can be calculated with the following formulas (ρ = medium resistivity of the ground).

a) Resistance of a vertical rod

$$Rd = \rho / L$$

L= length of the element touching the ground

b) Resistance of a horizontal rod

$$Rd = 2\rho / L$$

L= length of the element touching the ground

c) Resistance of linked elements

The resistance of a complex system with more elements in parallel is always higher than the resistance which could result from a simple calculation of elements in parallel, especially if those elements are close and therefore interactive. For this reason, in case of a linked system the following formula is quicker and more effective than the calculation of the single horizontal and vertical elements:

$$Rd = \rho / 4r$$

r= radius of the circle which circumscribes the link.

16.10. VOLTAGE ANOMALIES (VOLTAGE S AND SURGE)

The GENIUS5080E is able to record as voltage anomalies all those rms values, calculated every 10ms, beyond the percent thresholds of Voltage Reference (Vref) set during the programming from 3% to 30 % (with step of 1%).

The Reference must be set to:
Nominal Voltage Phase to Neutral: for Single Phase and 4 wire three phase system
Nominal Voltage Phase to Phase: for 3 wire three phase system

Example1: Three Phase System 3 wires.
Vref = 400V, LIM+= 6%, LIM-=10% =>
High Lim = 400 x (1+6/100) = 424,0V
Low Lim = 400 x (1-10/100) = 360

Example2: Three Phase System 4 wires.
Vref = 230V, LIM+= 6%, LIM-=10% =>
High Lim = 230 x (1+6/100) = 243,08V
Low Lim = 230 x (1-10/100) = 207,0V

The Instrument will detect Voltage anomalies if the RMS Voltage Values (calculated every 10ms) beyond the above calculated thresholds. These limits remain unchanged throughout the recording period.
When a Voltage anomaly occurs the instrument records:

- The number corresponding to the phase where the anomaly occurred.
- The “direction” of the anomaly: “UP” and “DN” identify respectively voltage drops (sag) and peaks (Surge).
- The date and time of the beginning of the event in the form day, month, year, hour, minutes, seconds, hundredths of second.
- The duration of the event, in seconds with a resolution of 10ms.
- The minimum (or maximum) value of voltage during the event.

16.11. VOLTAGE AND CURRENT HARMONICS

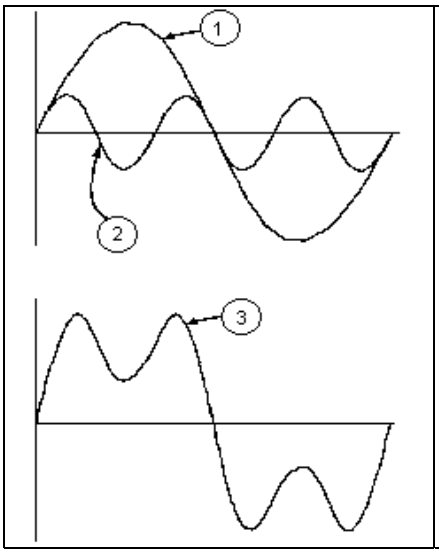
16.11.1. Theory

Any periodical non-sine wave can be represented as a sum of sinusoidal waves having each a frequency that corresponds to an entire multiple of the fundamental, according to the relation:

$$v(t) = V_0 + \sum_{k=1}^{\infty} V_k \sin(\omega_k t + \varphi_k) \qquad (1)$$

Where:

V_0 = Average value of v (t)
V_1 = Amplitude of the fundamental of v (t)
V_k = Amplitude of the k^{th} harmonic of v (t)



LEGEND:

1. Fundamental
2. Third Harmonic
3. Distorted Waveform

Affect of the sum of 2 multiple frequencies.

In the mains voltage, the fundamental has a frequency of 50 Hz, the second harmonic has a frequency of 100 Hz and the third harmonic has a frequency of 150 Hz and so on. Harmonic distortion is a constant problem and should not be confused with short events such as sags, surges or fluctuations.
It can be noted that in (1) the index of the sigma is from 1 to the infinite. What happens in reality is that a signal does not have an unlimited number of harmonics: a number always exists after which the harmonics value is negligible. The EN 50160 standard recommends stopping the index in the expression (1) in correspondence of the 40th harmonic.

A fundamental element to detect the presence of harmonics is THD defined as:

$$THDv = \frac{\sqrt{\sum_{h=2}^{40} V_h^2}}{V_1}$$

This index takes all the harmonics into account. The higher it is, the more distorted the waveform gets.

16.11.2. Limit values for harmonics

EN-50160 fixes the limits for the harmonic voltages, which can be introduced into the network by the power supplier. In normal conditions, during whatever period of a week, 95% if the RMS value of each harmonic voltage, mediated on 10 minutes, will have to be less than or equal to the values stated in the following table.
The total harmonic distortion (THD) of the supply voltage (including all the harmonics up to 40^{th} order) must be less than or equal to 8%.

Odd harmonics				Even harmonics	
Not multiple of 3		Multiple of 3		Order h	Relative voltage %Max
Order h	Relative voltage % Max	Order h	Relative voltage % Max		
5	6	3	5	2	2
7	5	9	1,5	4	1
11	3,5	15	0,5	6..24	0,5
13	3	21	0,5		
17	2				
19	1,5				
23	1,5				
25	1,5				

These limits, theoretically applicable only for the supplier of electric energy, provide however a series of reference values within which the harmonics introduced into the network by the users must be contained.

16.11.3. Presence of harmonics: causes

Any apparatus that alters the sine wave or uses only a part of such a wave causes distortions to the sine wave and therefore harmonics.
All current signals result in some way virtually distorted. The most common situation is the harmonic distortion caused by non-linear loads such as electric household appliances, personal computers or speed control units for motors. Harmonic distortion causes significant currents at frequencies that are odd multiples of the fundamental frequency. Harmonic currents affect considerably the neutral wire of electric installations.
In most countries, the mains power is three-phase 50/60Hz with a delta primary and star secondary transformers. The secondary generally provides 230V AC from phase to neutral and 400V AC from phase to phase. Balancing the loads on each phase has always represented an headache for electric systems designers.
Until some ten years ago, in a well balanced system, the vectorial sum of the currents in the neutral was zero or quite low (given the difficulty of obtaining a perfect balance). The devices were incandescent lights, small motors and other devices that presented linear loads. The result was an essentially sinusoidal current in each phase and a low current on the neutral at a frequency of 50/60Hz.
“Modern” devices such as TV sets, fluorescent lights, video machines and microwave ovens normally draw current for only a fraction of each cycle thus causing non-linear loads and subsequent non-linear currents. All this generates odd harmonics of the 50/60Hz line frequency. For this reason, the current in the transformers of the distribution boxes contains only a 50Hz (or 60Hz) component but also a 150Hz (or 180Hz) component, a 50Hz (or 300Hz) component and other significant components of harmonic up to 750Hz (or 900Hz) and higher.
The vectorial sum of the currents in a well balanced system that feeds non-linear loads may still be quite low. However, the sum does not eliminate all current harmonics. The odd multiples of the third harmonic (called “TRIPLENS”) are added together in the neutral and can cause overheating even with balanced loads.

16.11.4. Presence of harmonics: consequences

In general, even harmonics, i.e. the 2nd, 4th etc., do not cause problems. Triple harmonics, odd multiples of three, are added on the neutral (instead of cancelling each other) thus creating a condition of overheating of the wire which is extremely dangerous.
Designers should take into consideration the three issues given below when designing a power distribution system that will contain harmonic current:

- The neutral wire must be of sufficient gauge.
- The distribution transformer must have an additional cooling system to continue operating at its rated capacity when not suited to the harmonics. This is necessary because the harmonic current in the neutral wire of the secondary circuit circulates in the delta-connected primary circuit. The circulating harmonic current heats up the transformer.
- Phase harmonic currents are reflected on the primary circuit and continue back to the power source. This can cause distortion of the voltage wave so that any power factor correction capacitors on the line can be easily overloaded.

The 5th and the 11th harmonic contrast the current flow through the motors making its operation harder and shortening their average life.
In general, the higher the ordinal harmonic number, the smaller its energy is and therefore the impact it will have on the devices (except for transformers).

16.12. POWER AND POWER FACTOR DEFINITION

In a standard electric installation powered by three sine voltages the following is defined:

Phase Active Power: (n=1,2,3)	$P_n = V_{nN} \cdot I_n \cdot cos(\varphi_n)$
Phase Apparent Power: (n=1,2,3)	$S_n = V_{nN} \cdot I_n$
Phase Reactive Power: (n=1,2,3)	$Q_n = \sqrt{S_n^2 - P_n^2}$
Phase Power Factor: (n=1,2,3)	$P_{F\,n} = \frac{P_n}{S_n}$
Total Active Power:	$P_{TOT} = P_1 + P_2 + P_3$
Total Reactive Power:	$Q_{TOT} = Q_1 + Q_2 + Q_3$
Total Apparent Power:	$S_{TOT} = \sqrt{P_{TOT}{}^2 + Q_{TOT}{}^2}$
Total Power Factor:	$P_{F\,TOT} = \frac{P_{TOT}}{S_{TOT}}$

Where:

V_{nN} = RMS value of voltage between phase n and Neutral.
I_n = RMS value of n phase current.
f_n = Phase displacement angle between voltage and current of n phase.

In presence of distorted voltages and currents the previous relations vary as follows:

Phase Active Power: (n=1,2,3)	$P_n = \sum_{k=0}^{\infty} V_{kn} I_{kn} \cos(\varphi_{kn})$
Phase Apparent Power: (n=1,2,3)	$S_n = V_{nN} \cdot I_n$
Phase Reactive Power: (n=1,2,3)	$Q_n = \sqrt{S_n^2 - P_n^2}$
Phase Power Factor: (n=1,2,3)	$P_{F\,n} = \frac{P_n}{S_n}$
Distorted Power Factor (n=1,2,3)	$dPF_n = \cos f_{1n}$ = phase displacement between the fundamentals of voltage and current of n phase
Total Active Power:	$P_{TOT} = P_1 + P_2 + P_3$
Total Reactive Power:	$Q_{TOT} = Q_1 + Q_2 + Q_3$
Total Apparent Power:	$S_{TOT} = \sqrt{P_{TOT}^{\ 2} + Q_{TOT}^{\ 2}}$
Total Power Factor:	$P_{F\,TOT} = \frac{P_{TOT}}{S_{TOT}}$

Where:
V_{kn} = RMS value of kth voltage harmonic between n phase and Neutral.
I_{kn} = RMS value of kth current harmonic of n phase.
f_{kn}= Phase displacement angle between kth voltage harmonic and kth current harmonic of n phase.

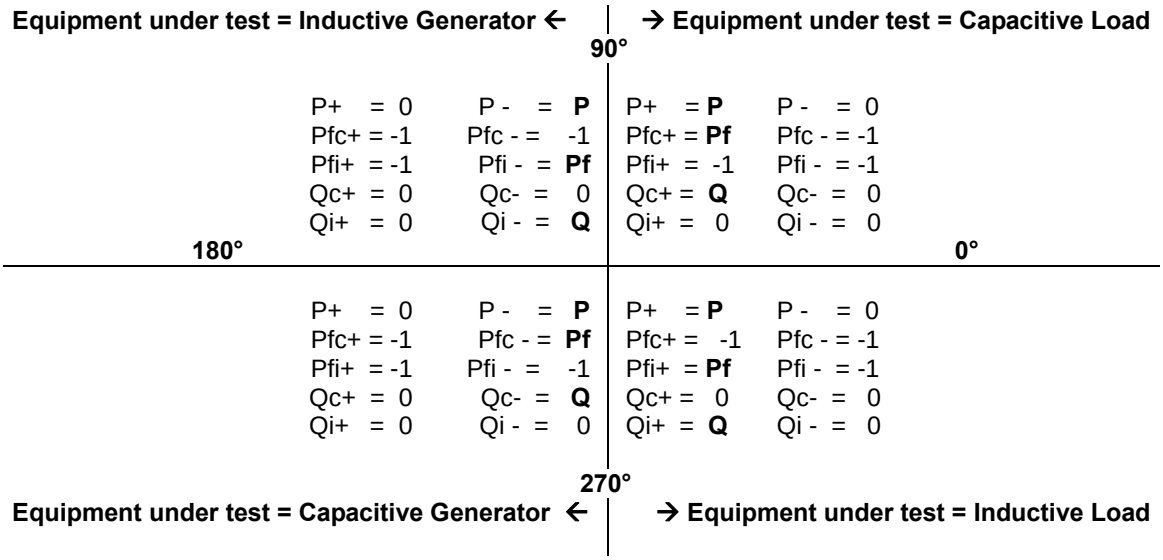
Note:

It is to be noted that the expression of the phase Reactive Power with non sine waveforms, would be wrong. To understand this, it may be useful to consider that both the presence of harmonics and the presence of reactive power produce, among other effects, an increase of line power losses due to the increased current RMS value. With the above given relation the increasing of power losses due to harmonics is added to that introduced by the presence of reactive power. In effect, even if the two phenomena contribute together to the increase of power losses in line, it is not true in general that these causes of the power losses are in phase between each other and therefore that can be added one to the other mathematically.
The above given relation is justified by the relative simplicity of calculation of the same and by the relative discrepancy between the value obtained using this relation and the true value.

It is to be noted moreover, how in case of an electric installation with harmonics, another parameter called distorted Power Factor (dPF) is defined. In practice, this parameter represents the theoretical limit value that can be reached for Power Factor if all the harmonics could be eliminated from the electric installation.

16.12.1. Conventions on powers and power factors

As for the recognition of the type of reactive power, of the type of power factor and of the direction of the active power, the below conventions must be applied. The stated angles are those of phase-displacement of the current compared to the voltage (for example, in the first panel the current is in advance from 0° to 90° compared to the voltage):



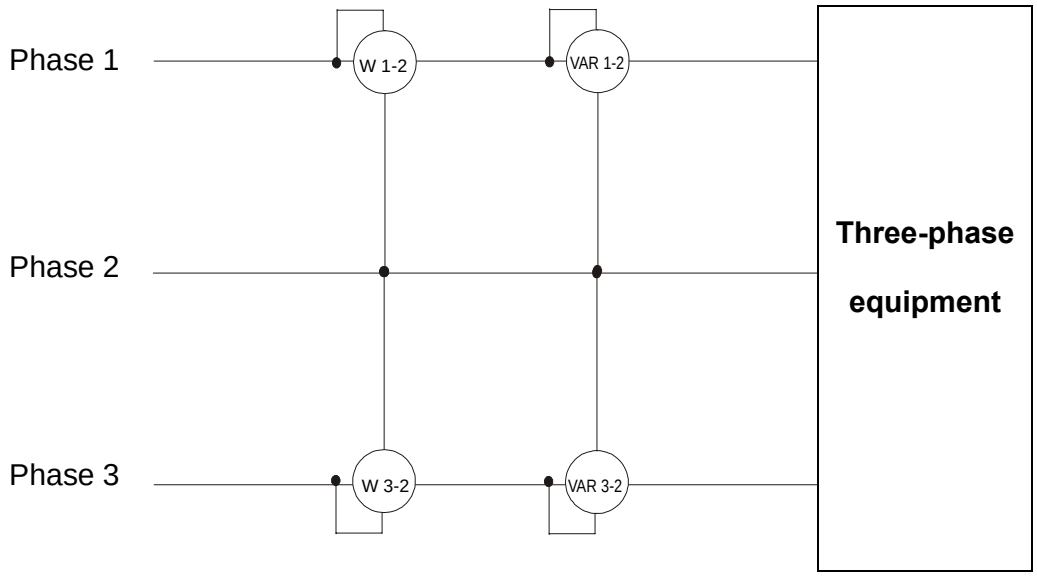
Where:

Symbol	Significance	Remarks
P+	Value of the active power +	Positive parameter (user)
Pfc+	Capacitive power factor +	
Pfi+	Inductive power factor +	
Qc+	Value of the capacitive reactive power +	
Qi+	Value of the inductive reactive power +	
P-	Value of the active power -	Negative parameter (generator)
Pfc-	Capacitive power factor -	
Pfi-	Inductive power factor -	
Qc-	Value of the capacitive reactive power -	
Qi-	Value of the inductive reactive power -	

Value	Significance
P	The active power (positive or negative) is defined in the panel and therefore acquires the value of the active power in that moment.
Q	The reactive power (inductive or capacitive, positive or negative) is defined in the panel and therefore acquires the value of the reactive power in that moment.
Pf	The power factor (inductive or capacitive, positive or negative) is defined in the panel and therefore acquires the value of the power factor in that moment.
0	The active power (positive or negative) or the reactive power (inductive or capacitive, positive or negative) is NOT defined in the panel and therefore acquires a null value.
-1	The power factor (inductive or capacitive, positive or negative) is NOT defined in the panel.

16.12.2. 3 Phase 3 Wire System

In the electrical systems distributed without neutral, the phase voltages and the power factors and phase cosφ lose importance. Only the phase to phase voltages, the phase currents and the total powers remain defined.



In this case the potential of one of the three phases (for example, phase 2) is taken on as reference potential. The total values of the active, reactive and apparent power are expressed as sum of the indications of the couples of Watt meters, VAR meters and VA meters.

$$P_{TOT} = W_{1-2} + W_{3-2}$$
$$Q_{TOT} = VAR_{1-2} + VAR_{3-2}$$
$$S_{TOT} = \sqrt{(W_{1-2} + W_{3-2})^2 + (VAR_{1-2} + VAR_{3-2})^2}$$

16.13. MEASURING METHOD: OUTLINES

The instrument is able to measure: voltages, currents, active powers, inductive and capacitive reactive powers, apparent powers, inductive and capacitive power factors, analogical or impulse parameters. All these parameters are analysed in a digital way: for each phase (voltage and current), 6 x 128 samples are acquired on a module of 16 x 20ms, repeated for the three phases.

16.13.1. Integration periods

The storage of all the data would require a huge memory capacity.
Therefore we've tried to find out a storage method which permits to compress the information to be memorised, though providing significant data.
The chosen method is the integration one: after a certain period called "integration period", which can be set from 5 seconds to 60 minutes (3600sec), the instrument extracts from the sampled values the following values:

- Minimum value of the parameter during the integration period (harmonics excluded)
- Average value of the parameter (intended as arithmetic average of all the values registered during the integration period)
- Maximum value of the parameter during the integration period (harmonics excluded)

Only this information (repeated for each parameter to be memorised) are saved in the memory along with starting time and date of the integration period.
Once these data are memorised, the instrument restarts to take measurements for a new period.

16.13.2. Power factor calculations

According to the standards in force, the average power factor cannot be calculated as the average of the instantaneous power factors. It must be obtained from the average values of active and reactive power.
Each single average power factor (of phase or total) is therefore calculated, at the end of each integration period, on the average value of the corresponding powers independently on the fact that they must be registered or not.
Besides, for a better analysis of the type of load present on the line and in order to have terms of comparison when studying the invoicing of the low $\cos\varphi$, the values of inductive and capacitive $\cos\varphi$ are treated as independent parameters.

17. APPENDIX 1 – MESSAGES DISPLAYED

Message	Description	Advices
AUTONOM:	Available memory autonomy for the recording which is being effected	
CLEAR ALL? (Enter)	The operator is trying to cancel all the recordings effected	Press ESC in order not to cancel the whole memory, press ENTER to confirm
CLEAR LAST? (Enter)	The operator is trying to cancel the last recording effected	Press ESC in order not to cancel the last recording, press ENTER to confirm
Data saved	The data have been saved	
DATA SIZE:	Dimensions of the stored data	
HOLD	By pressing the correct key, the HOLD function has been activated	Press HOLD again to disable this function
Password:	A recording has been started and at least 5 minutes have passed from the last activity of the instrument (see paragraph 7).	Insert the password: F1, F4, F3, F2
Invalid date	The inserted date is not correct	Check the inserted date
Energy Measuring	The instrument is taking an energy measurement	Press F1 to stop it
Memory Full	The memory of the instrument is full	Cancel some recordings after transferring them to a PC
No ext supply!	A recording has been started without connecting the external power supply (optional code MAR#####)	Verify if you really want to start the recording without the external power supply. In that case press START again.
No parameter sel	A recording has been started without selecting any value to be recorded	Press START/STOP and select at least a value entering the MENU
No Phase selected	Voltage and/or current harmonics have been selected and the corresponding flag has been enabled (HARMONICS ON) but no phase voltage or current has been selected	Select at least one phase voltage and/or current
PASSWORD ERROR	The inserted password is wrong (see paragraph 7).	Check the password
PASSWORD OK	The inserted password is correct	
Please wait	The instrument is waiting for the recording to be started (see paragraph 6)	
Recording	The instrument is recording (see paragraph 6)	
Too many param	More than 63 parameters have been selected (harmonics included) or More than 38 parameters with CO-GENERATION Flag enabled	Deselect some values
Too many records	The quantity of recorded data + Smp exceeds the maximum allowed (35)	Cancel some recordings after transferring them to a PC
No Unit selected		
ERR: SEQ	The Phase Sequence isn't correct.	Check the Phase Sequence connection.
ERR: P-	The active powers shown on the right side of the message are negative	If there isn't a situation of co-generation check if the clamps are properly connected
ERR: SEQ & P-	The active powers shown on the right side of the message are negative and the Phase Sequence isn't correct.	If there isn't a situation of co-generation check if the clamps are properly connected / check the Phase Sequence connection.
ERR: CONNECTION	The instrument has detected a wrong connection to Voltage inputs	Check the Voltage connections
Error Vref	The user set a Voltage reference not compatible with voltage at instrument's input.	Check Voltage Reference set in "CONFIG RECORDER"
ERR: SYNC	The System Frequency is out of range	Check the System Frequency, check setting in ANALYZER CONFIG.
Selection Error	There is a mismatch between the Parameter enabled and the parameter selected for an AUX recording.	Check the parameter enabled in AUX position and the selected parameter for recording.
Error1 - Error 5	The instrument memory is damaged.	Contact Martindale Electric

18. APPENDIX 2 – RECORDABLE PARAMETERS: SYMBOLS

Symbol	Description
V1	Voltage RMS value
freq	Network frequency
I1	Current RMS value
DC	Continuous component of voltage or current
h01 - h49	Harmonic 01 - Harmonic 49 of voltage or current
ThdV	Factor of total harmonic distortion of the voltage (see paragraph 16.11)
ThdI	Factor of total harmonic distortion of the current (see paragraph 16.11)
P1	Active power
Q1i	Inductive Reactive power
Q1c	Capacitive Reactive power
S1	Apparent power
pf1	Power factor
dpf1	cosφ
Ea1	Active energy
Eri1	Inductive reactive Energy
Erc1	Capacitive reactive Energy

Other products available from Martindale Electric

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- Multifunction Testers
- Calibration Equipment
- Continuity Testers
- Electrician's Kits
- Full Calibration and Repair Service
- Fuse Finders
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- Digital Multimeters
- Microwave Leakage Detectors
- Motor Maintenance Equipment
- Non-Trip Loop Testers
- Pat Testers & Accessories
- Phase Rotation
- Proving Units
- Socket Testers
- Thermometers & Probes
- Test Leads
- Voltage Indicators
- Specialist Metrohm Testers (4 & 5kV)
- Specialist Drummond Testers

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